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THE BOTANICAL GARDENS OF CEYLON

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"AN English glass house glorified" is the description which a British friend of the writer gave to the garden at Peradeniya, Ceylon. And such it truly is. The brilliant foliage, the strange orchids and pitcher plants, the luxuriant ferns, the uncanny screw-pines, are just what one might see in a gentleman's conservatory—only more wonderful and luxuriant, grown taller and more fair. As a "show place" these gardens are not equaled anywhere in the world and as a place of scientific interest to botanists there are few rivals. Haeckel, the German zoologist and philosopher, said of his visit to Peradeniya that in the four days which he spent there he learned more botany than he could have learned at home in as many months of hard study.[1]

Ceylon has been described as a "dew-drop on the brow of India" and so far as position is concerned it is certainly very closely related to the Indian peninsula. In climate, too, and in the flora and fauna, the northern part of the island is strikingly Indian; the same may be said of the inhabitants. On the other hand, southern and central Ceylon has a climate of its own and the people as well as the plants and animals are quite different.

Peradeniya is situated in the center of Ceylon about seventy miles by rail from Colombo, the capital of the island. There is no town here, but only a post-office and a few scattered huts. The city of Kandy, however, is only three miles distant by rail or wagon road.

In going from Colombo to Peradeniya the trains are slow, but the traveler does not complain. Indeed, he would wish his journey lengthened, for the trip affords a four-hour introduction to tropical scenery which is nowhere surpassed. Any one can enjoy the journey whether

[1] Haeckel, "India and Ceylon," Ch. VI.

interested in the world of nature or in his fellow man. There are broad lowlands with cocoanut trees and fields of rice, alternating with patches of deep jungle in which the natives have cleared bits of ground and built their huts. In the higher altitudes tea fields and chocolate plantations are the rule. But here also are stretches of uncleared forest with trees of all heights and sizes, frequently some with hand-

FIG. 1. VIEW IN THE *Pandanus* QUARTER OF THE PERADENIYA GARDENS, CEYLON. Note the curious prop roots of these trees. From a photograph by the author.

some red or violet colored flowers standing out boldly amid a mass of dark green.

The garden at Peradeniya is only one of a number on the island. It is, however, the largest and most important. Here are the offices of the director of the gardens, whose duties correspond to those of a government secretary of agriculture. Other gardens and experiment

stations, five in number, are established in parts of the island where differences in climate furnish altered conditions for plant life.

The Peradeniya garden is in the wet zone, or area of natural rain forest, at an altitude of 1,600 feet above the sea. With an annual precipitation of about 90 inches and a mean temperature of 75° Fahrenheit there are furnished the necessary conditions for luxuriant plant growth. A "dry season," extending through February, March and April, limits the growth of air plants hanging from trees, so that in this respect Peradeniya is not so interesting as Buitenzorg, in Java. The "dry season" is, however, not long enough to interfere with the growth of most plants and nearly all of the trees retain their leaves through this period. It is quite otherwise in the arid districts of northern Ceylon, where a monsoon forest with a considerable number of deciduous trees is the natural plant formation. Peradeniya, though rather too cool for cocoanuts or Para rubber, has a climate well suited to Castilloa rubber and to tea and chocolate, while palms of nearly all kinds thrive to perfection.

The garden was not originally laid out according to any system of plant classification, but was rather a beautiful park in which trees were planted for landscape effect. Now, however, the director,[2] is developing the garden according to systematic plans and making definite groups of plant families. Thus there are at present well-arranged plots devoted to palms, others to screw pines, others to cycads. It will necessarily be many years before the new plan can be fully carried out, for most of the plants in a tropical garden are trees. Indeed, the herbaceous garden forms but a small part of the whole.

Here, as in any first-class garden of the tropics, much is very new and strange to the botanist from temperate climes. Palms, screw-pines, giant bamboos, orchids and tree ferns, which he has known hitherto only from books or from the puny specimens of the plant house, become the commonplaces of every-day life. The sight of trees of the Composite family, Verbena family and many other groups represented at home only by herbs opens the eyes to some of the real wonders of tropical plant life. An interesting example is that of the "potato tree" belonging to the nightshade family. It does not produce potatoes, but its flower resembles that of a potato very much enlarged. At home we think of the nightshade family including only herbs and vines, but in the tropics it includes trees as large as our ordinary shade trees, such as elm and maple.

Nearly every kind of plant will grow at Peradeniya; tropical and sub-tropical plants very well indeed; temperate plants for the most part indifferently well. The latter are, however, taken care of at the mountain garden at Hakgala where the higher altitude (5,500 feet)

[2] John C. Willis, M.A. (Camb.), FL.S.

gives them a climate resembling that of western Washington and Oregon. The comparative coolness of tropical highlands is well illustrated by Nuwara Elliya, a resort near Hakgala, where in the hotels a grate fire is lighted nearly every evening throughout the year.

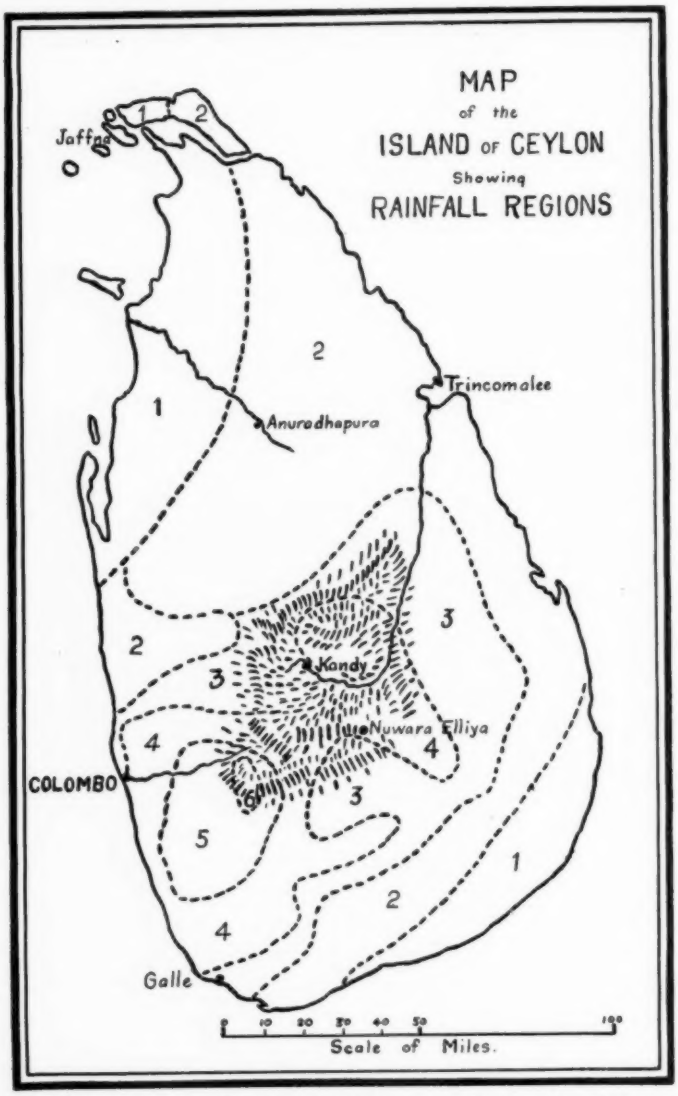

FIG. 2. MAP OF CEYLON. Peradeniya, not shown on the map, is about three miles east of Kandy in the central part of the island. The figures indicate annual rainfall as follows: 1, Under 50 in.; 2, 50 to 75 in.; 3, 75 to 100 in.; 4, 100 to 150 in.; 5, 150 to 200 in.; 6, 200 in. or more.

While an attempt is made to grow in the gardens all of the plants which are native to Ceylon, a great many plants from other parts of the world are also to be seen there. Indeed, the wealth of

tropical beauty is here assembled. The flame tree of Madagascar, named from the brilliant color of the flowers, is a wondrous sight in March and April, the whole tree being a mass of red which hides the dark-green foliage. From India there is a tree, *Saraca indica,* with a profusion of brilliant orange-yellow flowers; and from tropical America various trees of the genus *Brownea,* especially interesting because of the graceful clusters of pendant young leaves. The leaves droop when young and tender, thus presenting very little surface for injury by the overhead sun. As they grow older a horizontal position is assumed and the red color is lost. It is supposed that the red coloring matter acts as a screen which protects the living substance of the young leaves just as the red glass in a photographer's dark-room window protects the sensitive plates from injury by light.

Among the most interesting plants are the bamboos, of which many different kinds are cultivated, some native, others imported from peninsular India or from other parts of Asia. Some interesting studies have been made at the gardens on the rate of growth of bamboo stems. These spring up almost as if by magic. To measure the growth from day to day no expensive auxanometer is needed, but only a tape measure and a coolie to climb an adjacent tree with the end of the tape. A day's growth is measured not in millimeters but in feet or inches. Bamboo stems are hollow, as are most grasses—for bamboos are but grasses—and are wonderfully strong considering the weight and the amount of material in them. Indeed, the principle of the hollow cylinder so well known to engineers was long understood by the Asiatics, who use bamboos for building purposes.

Of economic plants in the garden there seems almost no end. The balmy breezes of Ceylon may well be spice-laden. Ceylon cinnamon is known the world over. The various peppers, as black pepper, long pepper, betel pepper, are woody climbers. A handsome grove of nutmeg trees is planted near the entrance—the trees about seventy years old. On the ground under the trees may be found the seeds, *i. e.,* the nutmegs, and around them a covering, the aril of the botanist, which forms the spice known as mace. Clove trees may be seen also; it is the young flower buds of the tree which are dried to make the cloves of commerce. In the garden one may see the plants which furnish vanilla, citronella oil, tea, indigo, pineapple, ramie, sisal hemp and sago. Almost countless trees there are of economic importance. A few may be named, as those which furnish coffee, chocolate, cola, cocoanut, Brazil nut, camphor, rubber, gamboge and other tropical products.

In speaking of economic plants mention must be made of the experiment station which is really a part of the garden, although situated across the river. As a matter of fact nearly all the world lies across the river from the Peradeniya gardens, as these are situated in a bend of the stream which flows first north, then west, then south

around the gardens. The experiment station was formerly a private estate bought by the gardens at a low price because it had been allowed to run down and the chocolate trees nearly all become diseased. Scientific methods of tending and care have been introduced and a model plantation developed. Here experiments are made with new agricultural crops and with new methods of treatment. The different species of trees furnishing rubber are being tried as well as improved varieties

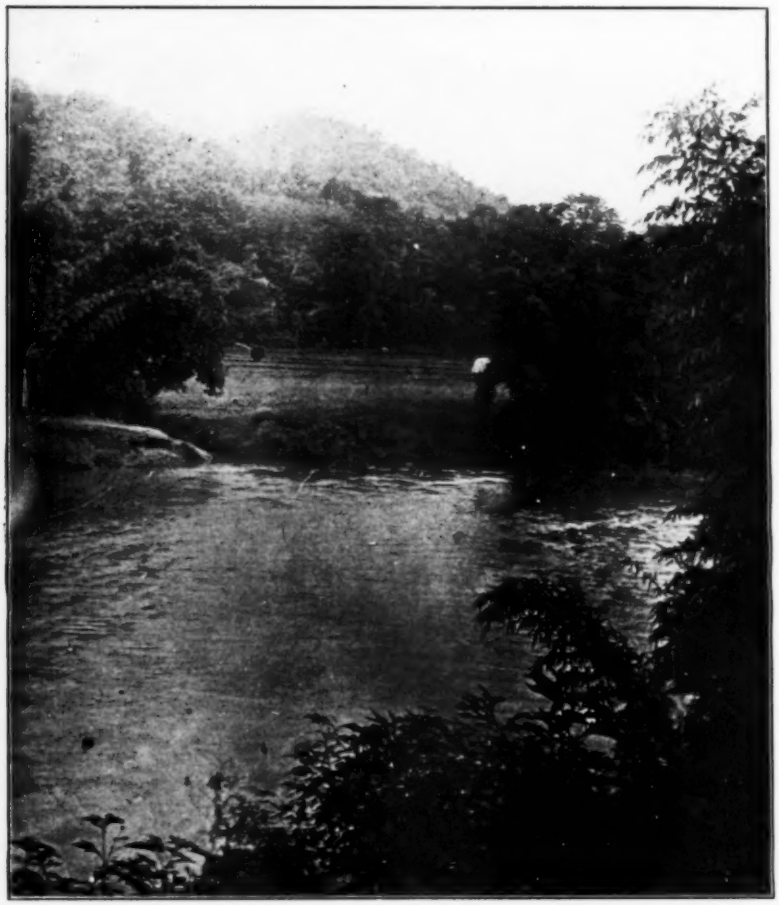

FIG. 3. BAMBOOS ALONG THE RIVER IN THE PERADENIYA GARDENS. In the clearing across the stream is a small rice field. From a photograph by the author.

of chocolate, cardomoms and other crops. Throughout Ceylon there is much general interest in scientific agriculture and the controller of the experiment station has the encouragement and moral support of the thinking population, both European and native. The daily newspapers at Colombo also give much attention to such matters and assume a sympathetic attitude toward government scientific work, in refreshing contrast to many of the newspapers in this country.

An attractive plot at Peradeniya is the Kitchen Garden, in which are assembled such "vegetables" as will grow in that hot, moist climate. Many of our common vegetables do well and can be had at all seasons, for example, beans, beets, peas, celery, lettuce and cress. Potatoes are generally small and poor. Sweet corn will grow in Ceylon, but has not thus far come into use. Of tropical vegetables various "yams" are much used, particularly by the natives. The word "yam" is applied to tubers and thickened roots of many different species of plants. Eggplants, different from ours in the temperate zone, are cultivated, also certain plants used, for "greens." Breadfruit trees produce the large heavy fruits of that name, but these would properly be classified among vegetables. Breadfruit is not much used by the British in Ceylon, who, in fact, eat chiefly the same things that they are accustomed to eat at home on their own tight little island.

Thus far we have been considering the attractions of the Peradeniya gardens to the casual visitor. To the botanist they are even more interesting. Every facility is offered by the director of the gardens for investigation by visiting men of science. There is a good herbarium in charge of competent curators and a working library of botanical books and periodicals. Good laboratory facilities are also offered. Although the laboratory for visitors is not fully equipped with physiological apparatus, there are the usual necessaries and it is easy to obtain all ordinary supplies at Kandy or Colombo. Native joiners, tinsmiths and metal-workers can be secured at very low rates to make articles needed. Photographic materials may be obtained at Kandy, only three miles away, and skilled photographers may be engaged to develop negatives or do other photographic work such as making lantern slides.

Opportunities for securing museum material are excellent. Collections of tropical woods properly named are prepared to order by dealers in Kandy. Plant material may be collected from the garden and preserved in formaldehyde or alcohol. Herbarium specimens from the garden can be collected and dried, but the botanist will need to remember that nothing short of the most thorough drying will suffice. It will also be necessary to use a liberal amount of naphthalene scattered through the dry specimens at all times. A native plant collector is detailed by the director of the gardens to assist visiting botanists in getting material from either the garden or the jungle. This man is well acquainted with nearly all of the species in the garden or growing in the vicinity and can usually tell the scientific name offhand, although sometimes he needs to refer to the herbarium. At the laboratory native assistants are provided who clean up apparatus and glassware and make themselves generally useful.

One of the most interesting things about Ceylon is the way in

FIG. 4. *Brownea*, A TREE WITH YOUNG LEAVES HANGING LIMP AT THE ENDS OF THE BRANCHES. At the right a Talipot palm in blossom. From a photograph by the author.

which the jungle comes to the very door of civilization. In our own country we do not find "backwoods" close to cities and towns, but must travel a long way from Boston or New York to find the primeval forest. Ceylon, however, like other tropical countries, furnishes examples of jungle in close proximity to the large towns. Indeed, everywhere throughout the island the forest is easily reached. There is no half-way land in Ceylon. That which is needed for roads, gardens or fields is well cared for; other land grows up quickly to jungle. Old fields, abandoned a few years, soon become a dense thicket and later a forest. This is well seen at Anuradhapura, one of the ruined cities in the north central part of the island. Here, the government archeologists, as they find various parts of buildings such as columns and arches, set them up in place; but sometimes they neglect to

clear out the trees for a sufficient distance and their "finds" once more become overturned by growing roots or the stems of gigantic climbers.

So, where jungle is the rule, and clearings have to be protected, it is natural that the botanical gardens should have a patch of jungle. This is situated in the experiment station grounds, but easily reached by the visitor. Here may be seen the native trees of the region in their natural condition and the visitor may get some idea of tropical luxuriance in the large number of species present on even a small tract of ground. It must be said, however, that a visit to this bit of jungle would be, to many visitors, a disappointment, for it is not filled with air plants hanging from the trees nor rendered impenetrable by interlacing stems of climbing plants. It is, however, much easier to travel through than the jungles at sea level in districts of great heat and humidity.

The botanist who is interested in ecology—the relation of the plant to its environment—is often on the lookout for field and roadside weeds. In temperate regions, particularly in the western United States, roadside weeds make a constant and striking feature of the landscape. This is not the case, as a rule, in the tropics. Indeed, there are not only rather few weeds, but few flowering herbs of any kind. The

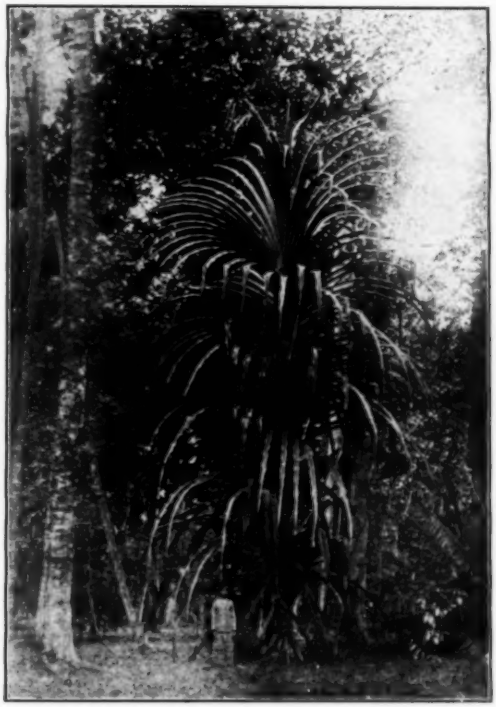

FIG. 5. A "SCREW PINE"; not a pine at all, but a monocotyledon of the genus *Pandanus*. From a photograph by the author.

tropics are a region of big things and the herbaceous plants make little impression on the visitor. At the Peradeniya garden, the writer noted a small area of perhaps half an acre that had been neglected for a time. Here, although there were many tree seedlings started, there was a fairly good patch of weeds—enough to make a lonely American feel quite at home. These weeds were chiefly *Lantanas* and some of our American composites, particularly the fleabane *Erigeron* and also *Conyza*.

It would be difficult to find elsewhere in the world an area the size of Ceylon, or even much larger, with so many different vegetation regions. The differences in these regions are brought about largely by

FIG. 6. LABORATORY AND HERBARIUM. At the far right is the office of the director. From a photograph by the author.

the winds which determine the distribution of rainfall and by altitude with consequent temperature changes. The wet weather comes with the rains from two different directions. The northeast monsoon commences in October and brings heavy rains throughout the higher parts of the island and in the lowland country of the northeast. A series of rains continues through November and December, with a rather light rainfall during January, February and March. In April the wind changes to southwest and there is more rain, with June especially wet. From then until October the rainfall is again lighter. It will be seen then, that in the highlands it is always moist, but that there are certain districts which have a rather pronounced dry season. The driest parts of the island are in the north and the south or northwest and south-

east, in other words, in those parts placed as outlying districts at right angles to the directions of both monsoons.

The climate at Peradeniya is such that the botanist can live there in comfort and work regularly. It is a good place to begin the study of tropical plant life, as it is not extreme in either rainfall or temperature. From Peradeniya it is easy to reach the various parts of the island with their remarkably different floras. Traveling is not expensive and as English is the regular commercial language it is easy to get around.

Although the different plant formations of Ceylon are almost without number, yet a rough classification may be made as follows: (1) lowland evergreen rain forest; (2) upland evergreen rain forest; (3)

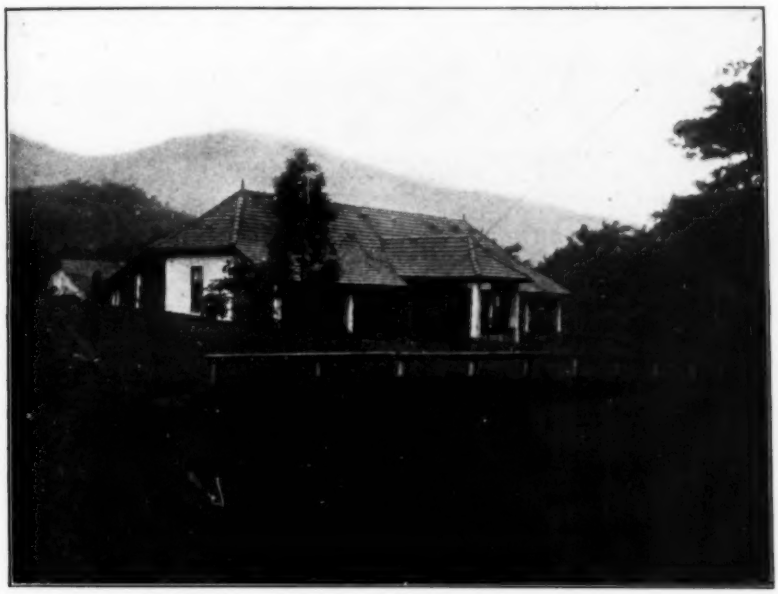

FIG. 7. GOVERNMENT REST HOUSE NEAR THE ENTRANCE TO THE GARDEN. From a photograph by the author.

mountain evergreen rain forest; (4) monsoon forest (half deciduous). There is no plain or prairie of any extent. Our first named formation is in the southwestern part of the island extending from Galle to Colombo and inland for twenty to fifty miles. Peradeniya is situated in the upland evergreen rain forest. Nuwara Elliya and Hakgala (about 6,000 feet altitude) may be taken as examples of our third region. These points are easily reached from Peradeniya by rail, the trip taking about half a day. Above these points the mountains rise 2,000 or 3,000 feet higher, but there is no true alpine vegetation anywhere in Ceylon. At Nuwara Elliya the general aspect of vegetation is much like that of temperate America or Europe. The trees are much

FIG. 8. A PORTION OF THE GARDEN, with formal beds and wide expanse of lawn arranged to please European tourists. From a photograph by Macmillan kindly furnished by the director.

stouter than those of lower altitudes and not so tall. In these mountain highlands in addition to forest there is a certain amount of "open country," the *patanas*. These are expanses of grassland on hillsides and rolling ground. The monsoon forest occurs in the drier regions of the island in the northwest and southeast. Here there are no very tall trees as compared with those of the rain forest and many of them are short and scrubby—very much branched after the manner of dry-country plants the world over. A considerable number are deciduous, losing their leaves in the hotter and drier months of spring to put them on again in the period of the monsoon or rain-bearing winds.

In the hot, moist lowlands of the southwest part of the island a typical strand flora may be seen. There are mangrove swamps and thickets of Nipa palm. It is in such very hot districts that rubber is grown and the cocoanut flourishes also. The drier regions have usually what would be a fair allowance of rain if in the temperate zone, but the tropical heat causes such rapid evaporation that the fifty inches of annual rainfall at Anuradhapura is not sufficient to grow crops without irrigation. Here then is a truly arid district. Farther north at Jaffna it is still drier, so that almost desert conditions prevail at least for a part of the year. As these dry regions can be visited easily at all times of year they make a very attractive feature of the island from the standpoint of the botanist. They are especially interesting to the American student familiar with the arid conditions of the west. In America all

arid lands are practically treeless, but in Ceylon the forest is the natural plant formation even in dry areas.

With all of the different floras to be seen in the various parts of the island a botanist may get a good idea of the tropical world in a short time and with slight expense. The director of the gardens and his staff are anxious to have scientific visitors, not only botanists, but zoologists and geologists as well. Two rooms at the government Rest House (a kind of hotel) are reserved for scientific visitors and no charge is made for lodging, although, of course, table board must be paid for. The cost of living will be found to be not more than in other tropical countries with fewer advantages for study.

Ceylon has never attracted a great number of students, but a considerable amount of valuable work has been done there. Haeckel certainly obtained many of his philosophical ideas of the plant and animal worlds during his visit to the island. Modern science and philosophy owe much to the influence of Ceylon on his writings. But Haeckel's zoological collections were also valuable, and the collections of others at later times have added much to the world's store of knowledge in regard to tropical life. On the side of botany probably the name which is oftenest associated with Ceylon is that of the late H. Marshall Ward, who as a young man spent two years on the island studying the coffee disease. Although he worked out the etiology of the disease and the life history of the parasite, he was unable to devise a method of prevention. Henry Trimen, who was director of the gardens at Peradeniya for sixteen years, published the "Flora of Ceylon," which was completed by Sir Joseph Hooker in 1900, after the death of Trimen. It is interesting to note that Hooker had himself collected plants in Ceylon fifty-three years before. Of recent publications the work of Mr. Willis, the director, on a curious family of plants, the Podosto-

FIG. 9. GIANT BAMBOOS. Photograph by Macmillan kindly furnished by the director.

maceæ, is especially noteworthy. An exhaustive study of the trees of the ebony genus has been made by Mr. Herbert Wright. Mr. R. H. Lock has also done some remarkably good work in plant-breeding experiments which deserve special mention. Various students have worked on minor problems, with results which have been published in both European and American journals. In June, 1901, there was begun the publication of the *Annals of the Royal Botanic Gardens, Peradeniya.*[3] This publication is issued at irregular intervals at a nominal price. It contains contributions from the director and other members of the scientific staff of the gardens.

The West Indies and the Philippines will, no doubt, attract more students of botany from America than will Ceylon, but in a few years no one will claim to be a trained botanist unless he has had the advantages of study in some tropical laboratory. There is no tropical land which offers better opportunity than Ceylon for botanical study. Nor can one find any tropical country with a more intelligent and progressive population, finer cities or more beautiful scenery.

One will naturally make comparisons between botanical opportunity at Peradeniya and at Buitenzorg,[4] in Java. It may be said that the establishment at Buitenzorg is much older and better provided with funds, but that Peradeniya is a more comfortable place to live, that traveling is much less complicated and communication more easy because of the use of English by the natives. In Java one must learn Malay in order to communicate with servants. On account of the very moist climate, Buitenzorg presents a more luxuriant vegetation, but this very great moisture makes work harder, and in the afternoons it is practically impossible to do any kind of study in the garden on account of rain. To many people the large number of visitors in the Buitenzorg gardens seems a detriment. The place is too much "civilized." At Peradeniya, on the other hand, the number of casual visitors is rather small, and they do not embarrass the student by their presence or their questions. It will be seen that it is impossible to say which of the two places will be better for the student. Something depends on the kind of work he wishes to do and very much depends on his own temperament. In fact, both gardens should be visited, and the length of time spent in each be determined by conditions as they arise.

[3] Students interested in knowing more concerning the opportunities for research at Peradeniya should consult the first number of the *Annals* in which these opportunities are fully set forth. An excellent account of the island of Ceylon with a statement of its resources is given in the "World's Fair Handbook of Ceylon," prepared for the St. Louis Exposition.

[4] See an article by the present writer in this magazine for November, 1905.

THE PREHISTORIC ABORIGINES OF MINNESOTA AND THEIR MIGRATIONS[1]

By N. H. WINCHELL
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IT would have been considered an act of great temerity twenty-five or thirty years ago to enter upon an investigation of the Indians of Minnesota in prehistoric time. But, thanks to the rapid progress that has been made in aboriginal research in North America, chiefly under the guidance of the late J. W. Powell and his associates in the Bureau of Ethnology at Washington, it is now necessary only to apply to Minnesota some of the great truths that have been established as to the Indians at large, and to designate under those principles what Indian stocks and tribes have inhabited the state in some of the centuries that preceded the advent of the whites.

In order to clear the field at the outset by the removal of any obstacles that we may have inherited from earlier conceptions of the aborigines, it will be well to repeat some of the important results that have been reached within recent years, viz.:

1. The origin of the ancestors of the Indians was so remote that nothing yet discovered indicates its date or the source from which they came.

2. There are between fifty and sixty Indian stock languages, some of which are as distantly related as the languages of the various Aryan nations, but most of which are as distinct as the English from the Semitic.

3. This shows that the aborigines, if they came at all to America, must have come from a great many directions, or that their coming was so remote that they must have developed these differences amongst themselves by long periods of isolated residence in North America.

4. The Indian stock languages can not be connected, at least have not been connected as yet, with any convincing bond of relationship, with either European or Asiatic languages. The Eskimo are here not included, as that stock ranges from Greenland through North America into Siberia.

5. The aborigines, therefore, are indigenous to the soil of America in the same sense that the Mongolian and Caucasian are indigenous in the lands of the Eastern continent.

6. The "moundbuilders," that fabulous race of Squier and Davis,

[1] An address before the Minnesota Historical Society, February 9, 1907.

were the ancestors of some of the Indian tribes of history. What those tribes were is gradually being unraveled.

7. The greatest number of the aboriginal language stocks were located along the Pacific coast, say in California, and along the Atlantic and Gulf coasts in the southeast; the interior of the continent being occupied thinly by only three or four stock tongues, these being Athapascan, Shoshonean, Algonquian and Siouan. The Kiowa, who

also were in this central area, are thought by some to be an independent stock, but by others related to the Comanches, and hence may, for our present purpose, be classed with the Comanches in the Shoshonean family. The Pawnee, or Caddoan, family was feebly represented in the interior of the continent aside from their main habitat at the gulf coast and in Texas; but the Iroquois shared with the other wide-spread families in the possession of the interior. These, however, appear to have linguistic alliances with the Cherokees and more distantly with the

Siouan stock. Hence again, for the purpose of the present discussion, the Iroquois may be considered with the Siouan family.

Of these four great family stocks it will be the purpose of this paper to deal mainly with the last two mentioned, *i. e.*, the Algonquian and the Siouan.

In the Algonquian family are embraced the following tribes, as stated by J. W. Powell, as well as several other small tribes that dominated the north Atlantic coast; the arrangement here is that of D. G. Brinton in the previsional order of their linguistic affinities, the oldest and perhaps the parent tongue, the Kilistino, heading the list:

Cree (Kilistino)
Old Algonkin
Montagnais
Ojibwa
Ottawa
Pottawotomi
Miami
Illinois
Pea
Piankishaw
Kaskaskia
Menominee
Sac
Fox
Kikapoo
Micmac
Etchemin
Abnaki
Delaware
Shawnee
Mohecan
Nanticoke
Gros Ventres (of the Plains)[1]
Sheyenne

To these may be added the Arapahoe, associates of the Sheyenne in Wyoming, not mentioned by Brinton. These show, according to Krœber, certain characteristics that mark them as differing from the other Algonquians, both in speech and in tribal organization. There is no history or tradition of their origin. They have no clans nor totemic divisions, whereas these are marked features of the most of the Algonquian stock. Certain more elemental characteristics of their dialect, and the certainty of their having long preceded the Sheyenne in their present habitats, seem to warrant the assumption that they are more primitive than even the Kilistino.

The area formerly occupied by the Algonquian family was more extensive than that of any other linguistic stock of North America, their territory reaching from Labrador to the Rocky Mountains, and from Churchill River of Hudson Bay as far south at least as Pamlico Sound of North Carolina. (Powell.)

[1] There were two tribes of Gros Ventres, so named by the French, distinguished as Gros Ventres of the Missouri, a tribe of the Siouan tongue, and Gros Ventres of the Plains, who were Algonquian.

The Dakotan, or Siouan, family comprised the following Indian nations, arranged approximately in order of apparent derivation:

Biloxi
Tutelo
Waccon
Catawba
Huron Iroquois?
Cherokee?
Winnebago
Omaha
Osage
Issati
Mandan
Missouri
Dakota
Iowa
Ottoe
Hidatsa (and Crows)

having numerous subtribes, viz., Santee, Sisseton, Wahpeton, Yankton, Yanktonai, Teton, Blackfeet, Minneconjou, Ogalala, Ponka, Assiniboin, Akansea, Kansa and others.

The position above assigned to the Cherokee and Iroquois is conjectural, but is based on the statements of some authorities. Mr. Horatio Hale has sufficiently established the connection between the tongues of the Cherokee and the Iroquois, and Mr. Mooney has shown the relation between the Cherokee and the primitive tribes of the tongue in South Carolina. It may be that the alliance of the Iroquois with the Dakotan stock is so feeble that the two should be considered as separate stocks. But, for reasons that will appear, the Cherokee (Tselaki), the ancient Alligewi, seem to have had an ancestry which was cognate with that of the Dakota. It will be shown that they both moved from their pristine seat on the Atlantic coast in the Carolinas, where some archaic remnants of both tongues still continued in early American history.

The country occupied by the great Dakota stock, aside from the small tribes that remained near the Atlantic, was, in general, the "interior continental basin" so far as it lay west of the Mississippi River and east of the Rocky Mountains, with a broad tongue that extended into Canada so as to take in some of the waters that reach Hudson Bay, west of Lake Winnipeg. It covered the Missouri Valley except in its utmost upper reaches in the region of the Yellowstone Park, which belonged to the Shoshonean stock, and excepting also the valley of the Platte. It extended eastward in a narrow tongue, across the Mississippi, through southern Wisconsin to Lake Michigan, an anomalous geographic exception, the important significance of which will be referred to later. As to Minnesota, it was divided between the Algonquian and the Dakota stocks, the larger part being in possession of the Dakota. The Kilistino, an Algonquian tribe, were in the north and northeast, in the wooded region north of Lake Superior. Their

dominion included the boundary waters not farther west than Rainy Lake, but continued unbroken to Hudson Bay.[3]

A few other general considerations ought to be stated at this point in order to prepare for the discussion of the topic in hand. These are:

1. During the prevalence of the last ice-epoch the state of Minnesota was covered with ice, and all previous inhabitants, whether fauna or flora, were driven southward to more congenial climes.

2. This condition ended between seven and eight thousand years ago. It is not necessary here to rehearse the investigations on which that result is based.

3. Between the ice-fields and the habitable portions of the continent lying to the south was a belt of country, the width of which varied according to the longitude and according to the topography, which was uninhabitable by reason of the severity of the climate. This uninhabitable belt may be compared to a belt in northeastern and northern Canada at the present time which is uninhabitable for the same reason. It was wider, however, than the northern Canadian belt, and less ameliorated along the banks of the rivers. Their waters drained from the northern ice fields, whereas the Canadian rivers carry waters from southern and more temperate latitudes. But like the Canadian belt it was wider toward the west. The ice-margin and the accompanying severity of climate crossed the country from southeast to northwest. The prehistoric isothermals, same as the present, passed northwestwardly.

4. Hence the habitable portions of the United States, until seven or eight thousand years ago when the ice began its retreat, were along the Atlantic seaboard south of New Jersey, a belt along the coast of the Gulf of Mexico, a large interior area without ascertainable limits, and the Pacific coast west of the Sierra Nevada.

5. So far as Minnesota is concerned, and the same is true of much of the northern United States, it seems to be necessary, therefore, to confine all investigation of aboriginal migration to an antiquity not greater than seven or eight thousand years.

6. For Minnesota it is necessary to make a still further restriction, for it was the ice-margin itself that retired seven or eight thousand

[3] Powell's map of linguistic stocks accompanying the seventh annual report of the Bureau of Ethnology, 1885–6, is quite incorrect for Minnesota. It gives by far too much area to the Algonquian. The boundary as shown by his map would be more applicable in the eighteenth century, after the inroads of the Ojibwa upon the Dakota had won a large part of the state. As it should be drawn from the earliest known habitats of the aborigines, it should start from the St. Croix River not far from the eastern side of Pine County, run thence northwardly to near the east end of Rainy Lake, thence northward and northwestward so as to leave Lake of the Woods to the Assiniboin, but to the southward of Lake Winnipeg and thence northwestwardly indefinitely to the valley of the Saskatchewan.

years ago from the vicinity of the falls of St. Anthony. It required, maybe, two thousand years more for the passage over the state of that uninhabitable belt already mentioned.

7. The people along the gulf coast and on the ocean shores would not have been quick to follow up the retiring cold of a glacial winter. They would not readily leave the warm lowlands, where food was abundant, to penetrate the wastes of a country that was still swept by cold winds and whose wide-spreading waters were chilled by the dissolution of the northern ice.

8. The occurrence, however, of an opportunity for migration was equivalent to the creation of an impulse, and after a time the southern tribes moved into the regenerated new country.

It is the purpose of this paper to give a glimpse of some of the movements of this migration, and to show how it affected Minnesota. The time within which these migrations occurred, for reasons already stated, can not therefore exceed five or six thousand years.

It will be reasonable to assume that wherever the chance for hopeful migration first presented itself there the first movement took place. Some weaker tribe was expelled by war, or, the people being crowded, some tribe sought more room and better quarters to expand in. This change must have begun in the southwest, perhaps no further south than Utah or Colorado, or perhaps some tribe of Mexico began the great migration. The same impulse toward northward migration was felt all along the gulf coast and on the Atlantic seaboard. Sometimes whole tribes abandoned their ancient seats and sometimes only a discontented portion of a tribe parted from their kindred. There must have been many conflicts and counter migrations and movements in all directions; but those who started first probably continued to move in the van as they were again pressed by those in the rear.

When there came finally a condition comparatively fixed, it must be allowed that the tribes had settled where their environment was best suited to their needs, subject, of course, to the dominance of more powerful tribes. It may be reasonably accepted that on attaining a condition of comparative quiet, the geographical situation of the linguistic stocks was approximately as represented on the linguistic map of Powell, barring, of course, such later changes of habitat as can be shown to have taken place either within historic time or by consistent application of tradition. A general sketch of the Powell linguistic map has already been given.

It is now necessary to examine it a little more closely and to note some of the more remarkable features. It is a most notable fact that the southern parts of the United States are thickly dotted over with small areas that denote the locations of numerous distinct aboriginal stocks, while the broad interior is occupied by a few widely spread

stocks that were, as is known, thinly dispersed along the river courses and ranged in pursuit of game or of their enemies occasionally over the plains. The Athabascan stock, now occupying the interior of Alaska and of northern Canada, may be presumed to have been the first, or among the first, to leave their pristine seats. But they must have left a considerable number of their friends at home, since they still subsist in a large tract in eastern Arizona, western New Mexico and southwestern Texas, under the names of Apache and Navajo, with their subdivisions. The Shoshonean family may not have moved far from their pristine home, at least seem not to have entirely abandoned it, since the Shoshonean area still lies contiguous to the Pacific coast in southern California. They apparently simply improved the opportunity of expansion, and latterly perhaps dispossessed some weaker tribes. Still, it is quite possible that the Shoshonean people were powerful and spread over a wide interior area from which they have never departed even during the prevalence of the glacial climates of the north.

The two great Indian families, however, in which we are most interested are the Algonquian and the Siouan. Let us notice the contrasts in their distribution. The Algonquian spreads over the northeastern part of the United States and Canada, with a small root lingering adjoining the Shoshonean in Colorado, but has no representative on the southeast Atlantic coast. It is true that according to the map the Algonquian stock extends as far south on the Atlantic seaboard as North Carolina, but this southward expansion there is of later date and can be excluded from the discussion. Indeed, the whole Delaware confederacy, covering the Algonquian areas in New Jersey, New York, and some portions of New England as well as all of that in the states of Kentucky, West Virginia, Ohio, Indiana and the most of Illinois, can likewise be excluded, since, as will appear, their acquisition of those areas is of comparatively recent date. It appears, therefore, if the Algonquian stock was governed in post-glacial time by the forces which have been mentioned, that that people started from the southwestern country, spread over the interior plains, and preempted the timbered regions of Canada and the northern United States. It hence follows that the northern part of Minnesota, Wisconsin and Michigan, and the most of New England were the first settled habitats, in the United States, of the Algonquian people. Prior to the Dakotan incursion, the Algonquian probably controlled areas farther south, especially in Minnesota, while the mainly uninhabited interior, *i. e.*, the plains of the Missouri and of the upper Mississippi, were the fields over which for a long period of time all the surrounding nations sent war parties and hunters, but did not venture to make permanent settlements.

Now compare with this the distribution of the Siouan stock. It has two small areas on the Atlantic seaboard contiguous to similar areas

of the Iroquois, but its main area is west of the Mississippi, embracing the wide plains over which roamed the buffalo. These areas are separated by the states of West Virginia, Kentucky, Ohio, Indiana, Illinois and Michigan, where now reside the Algonquian, or at least where they were found by the Europeans when they made acquaintance with the region. Guided by the same principles, we may infer reasonably that, on the amelioration of the glacial climate, the Siouan family, residing wholly on the southeastern Atlantic seaboard, migrated toward the north and west, crossing the mountains that bound them in, and sought the plains on the west. With the vicissitudes of war and the lapse of thousands of years, those who remained on the east side of the Alleghany Mountains were permanently separated from those who migrated, and the western tribes expanded rapidly over the western plains of the Missouri, becoming powerful and a scourge to their neighbors, "the Iroquois of the West," as they have been termed not inaptly.

We can infer, therefore, that these two stocks, the Algonquian and the Siouan, moving, one from the southwest and the other from the southeast toward the Mississippi Valley, early came into collision, and that in the main the Mississippi River at first constituted the boundary line separating their domains. This early hostility became a hereditary war, and on the side of the Siouan stock the Iroquois also participated. I do not know of any record, and of but one tradition, of war between the Iroquois stock and the Siouan stock west of the Alleghanies, but both these stocks maintained bitter and hereditary war against the Algonquian. The prehistoric Siouan people were neighbors in the Carolinas of the prehistoric Iroquois, and the two people more or less allied in language and having similar customs and the same opportunities for northward migration probably moved about simultaneously, both tribes crossing the mountains into the country where the waters flowed in the western direction, the Iroquois to the north of the Sioux.

It is a remarkable fact that, with the exception of the earthworks of the gulf coast, these two stocks are the only ones that have been found to have had a general custom of constructing earth mounds and embankments.[4] These common resemblances, regardless of any

[4] The mounds that are common in southern Michigan and along the Lake Huron shore northward from Detroit, as well as those in northern Ohio and western New York are attributable to the Iroquois or to some of their kindred tribes, viz: the Hurons, Eries and Neutrals. The Iroquois dominion extended to the north shore of lake Huron even in historic time. An old Dutch map of 1690 (?) published by Van der Aa has "Iroquoysen" in the northern part of Wisconsin. Indeed there is good reason for believing that the Iroquoian and Siouan stocks at this time possessed the whole country east of the Mississippi River and south of the Great Lakes to northern Georgia, constituting together the great Ohio dynasty of the mound-builders. The true earth mounds of northern Wisconsin are probably later than this period. Mr. Geo. A. West says

linguistic affinity, are sufficient to point to an early common origin. If the Algonquian stock in any of its tribes is found to have constructed mounds, such as those characteristic of the Ohio mound-builders, it seems to have been only exceptional or sporadic, or may be attributed to adoption from their neighbors belonging either to the Iroquois or the Siouan stock. I know that Dr. Thomas has shown the great probability that the Shawnees, an Algonquian tribe, were the authors of certain mounds in western Tennessee and contiguous territory farther southeast, and specially of those that cover the characteristic stone-box graves. Admitting that, it is still true that the Shawnees have not been shown to have been mound builders in a wide sense, and that, carrying the habit of subsurface burial with them when they left their kindred and migrated into southern Illinois and western Tennessee, they might easily have adopted the custom of their mound-building new neighbors and covered their box graves with earth mounds. But, without admitting at present that the Shawnees constructed the mounds that cover the stone-box graves, it seems to be reasonable to refer those mounds to the predecessors of the Shawnees, viz.: the Osage and perhaps the Omaha, who belong to the Dakotan stock, and who have a tradition, which is confirmed by other traditions, that they once lived east of the Mississippi in that very region. With this understanding, it is, I repeat, a remarkable fact that, aside from the Muskogean earthworks of the gulf coast, which have distinctive characters, only the Dakotan and Iroquois stocks can be shown either by history or tradition to have been characteristic mound-builders.

It is due to the research of the late J. V. Brower that the Dakota tribes of Minnesota have been proved to belong to the so-called mound-builder dynasty. But the mound-builder domain was, *par excellence,* in the Ohio Valley and southward into Kentucky, Tennessee and northern Georgia and eastward into West Virginia. There is also a remarkable series of effigy mounds in central and southern Wisconsin which extended across the Mississippi into Minnesota and Iowa. With slight exceptions the typical mound-builder area was occupied, as shown by Powell's map, at the coming of the whites, by non-mound-building people; while the great body of the mound-builders, represented by the Siouan stock, were on the west side of the Mississippi, in a region which had been passed by, or ignored, by the early migrating stocks.

As between a prairie and a forested country it is plain that the forested area would be chosen first by the aborigines. Aside from the

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that the Sioux at different periods occupied the greater part of what is now Wisconsin. Mounds have been described by John T. Short ("North Americans of Antiquity," p. 30) in the valley of the Columbia River, south from Olympia, but these have since been ascribed to natural causes by Messrs. Rogers and Upham (*Am. Geol.*, Vol. XI., p. 293 and Vol. XXXIV., p. 203).

shelter afforded by the timber, the forests yield food more easily captured, as well as material for his habitation and for his implements of war and the household; while the annual devastation by fire rendered the prairie not only uninhabitable, but actually dangerous. It is certain, therefore, that the occupancy of the prairies has been, in general, the latest step in the establishment of the dominion of the aboriginal tribes. In other words, it is only a late migration which has brought the Siouan tribes into the plains of the Missouri and of the upper Mississippi, and with this fact agrees all the evidence that can be found that bears on it, whether from a study of the people themselves, of the mounds, or of their traditions.

It will be anticipated, from what has been said thus far, that the original mound-builder dynasty in the Ohio Valley was destroyed by an incursion of hostile people belonging to the Algonquian stock. It will be the burden of the rest of this paper to establish that great prehistoric event, and to show what effect it had on Minnesota.

Dr. Cyrus Thomas is to be accredited with the most thorough investigation of the aboriginal earthworks of the country. Under the direction of the Bureau of Ethnology he has established some important generalizations and has traced out some of the movements of the tribes that were concerned in the war which resulted in the expulsion of the original mound-builders from Ohio and the contiguous regions. Suffice it to say here that he considers that the evidence shows a movement, at least an extension, of the earliest mound-builders from the region of eastern Iowa, southeastern Minnesota, and southwestern Wisconsin, across Illinois and Indiana into Ohio. He shows that these people were driven out toward the east and southeast. He traces this retreat, which may have required several hundred years for its completion, with the most patient and convincing research, and arrives at the conclusion that when the whites came upon the scene the defeated and expelled people were known as Cherokee, living in western North Carolina and eastern Tennessee, and were still building mounds. The last statement is abundantly verified even by historic documents. De Soto met them in his trip across the cis-Mississippi region, and his chroniclers describe the mounds which they saw. Some of the mounds built by the Cherokee in their new home contain articles of European manufacture.

But this line of persistent aggression from the northwest to the southeast, resulting in the expulsion of the Cherokee from the upper part of the Ohio Valley, was not the whole of the great war, though it is the only part that has been established by evidence like that adduced by Dr. Thomas. It can hardly be questioned that such an incursion would have had a disastrous effect on the mound-builders of the whole Ohio Valley, and that they were all driven out at the same time and by the same hostile force.

It is necessary now to rely on tradition, and on the preliminary considerations already presented, to show what became of the rest of the moundbuilders of the Ohio dynasty. It is apropos, however, to remark that the whole of the moundbuilding people could not have escaped by the route traced out by Thomas up the valley of the Kanawha River. By far the larger part of them had a habitat further south and further west, and the most probable line of retreat for them was down the Ohio Valley.

There are many traditions that relate to the migrations of the native tribes within the United States. I will call your attention to but two of them. These relate to the great movements that are here discussed, but they are confirmed by several others that supply contributory details, and when taken all together their force amounts almost to as great a body of evidence as if the events were a matter of history.

These two traditions have been accepted by all archeologists as trustworthy testimony, as far as the Indians could communicate a history of past events. The only differences of opinion that have appeared pertain to the interpretation and application of the traditions themselves.

One of these two traditions recounts the hostile incursion of the Lenni-Lenape, an Algonquian tribe or group of tribes, into the region west of the Alleghany Mountains, their conflict with the "Tselaki," a word which has been corrupted into Cherokee, and with the Allegewi, a word which is perpetuated in the term Alleghany, and their final settlement, under the name Delaware, in the eastern part of Pennsylvania and in New Jersey, together with some further migrations toward the east. The other relates to the migration of some of the Siouan tribes down the Ohio River and their going "up stream" and "down stream" on the Mississippi on reaching the mouth of the Ohio. I do not know that any one has called in question the essential parts of this tradition.

John Heckewelder, a Moravian missionary with the Delaware or Lenni-Lenape in Pennsylvania, gave the first printed account of the hostile incursion of the Lenni-Lenape against the Ohio mound builders. It is published in Vol. XII. of the memoirs of the Historical Society of Pennsylvania, in 1818. He took it from the relation of the intelligent Indians. With some abbreviation it is as follows:

"The Lenni-Lenape (according to traditions handed down to them by their ancestors) resided many hundred years ago in a very distant country in the western part of the American continent." For some reason they determined on migrating to the eastward, and accordingly set out together in a body. After a very long journey, and with many long stops on the way, they at length arrived on the "Namaesi-sipu," which by Mr. Heckewelder is translated "Mississippi, or River of

Fish," when they fell in with the Mengwe, who had likewise emigrated from a distant country, and had struck upon this river somewhat higher up. [The Mengwe were the Iroquois.] "Their object was the same with that of the Delawares: they were proceeding on to the eastward until they should find a country that pleased them. The spies which the Lenape had sent forward for the purpose of reconnoitering had long before their arrival discovered that the country east of the Mississippi was inhabited by a very powerful nation, who had many large towns built on the great rivers flowing through their land." These people called themselves Tallegewi or Allegewi. [According to later research this is the aboriginal rendering of the name "Tselaki" which De Soto gives to the Cherokee when he encountered them at a much later date farther south.]

Many wonderful things are told of this famous people. They are said to have been remarkably tall and stout, and there is a tradition that there were giants among them, people of much larger size than the tallest of the Lenape. It is related that they had built for themselves regular fortifications or entrenchments, whence they would sally out, but were generally repulsed. I have seen many of the fortifications said to have been built by them.

When the Lenape arrived on the banks of the Mississippi, they sent a message to the Allegewi to request permission to settle themselves in their neighborhood. This was refused them, but they obtained leave to pass through the country and seek a settlement farther to the eastward. They accordingly began to cross the Namaesi-sipu, when the Allegewi, seeing that their numbers were so very great, and in fact consisted of many thousands, made a furious attack on those who had crossed, threatening them all with destruction if they dared to persist in coming over to their side of the river. Fired at the treachery of these people and the great loss of men they had sustained, and besides not being prepared for a conflict, the Lenape consulted on what was to be done, whether to retreat in the best manner they could, or try their strength and let the enemy see that they were not cowards, but men, and too highminded to suffer themselves to be driven off before they had made trial of their strength and were convinced that the enemy was too powerful for them. The Mengwe, who had hitherto been satisfied with being spectators from a distance, offered to join them on condition that after conquering the country they should be entitled to share it with them. Their proposal was accepted, and the resolution was taken by the two nations to conquer or die.

Having thus united their forces, the Lenape and the Mengwe declared war against the Allegewi, and great battles were fought in which many warriors fell on both sides. The enemy fortified their larger towns, and erected fortifications, especially on large rivers and near lakes, where they were successively attacked and sometimes stormed by the allies. An engagement took place in which hundreds fell, who were afterward buried in holes, or laid together in heaps, and covered with earth. No quarter was given, so that the Allegewi at last finding that their destruction was inevitable if they persisted in their obstinacy, abandoned the country to their conquerors, and fled down the Mississippi River, whence they never returned. [Mr. Heckewelder gives some further details of the war, the result of which was that the Mengwe, or Iroquois, chose the country round the Great Lakes and the St. Lawrence River, and the Lenape settled farther south. After a time the Lenape moved farther east, and even to the sea.]

They say, however, that the whole of their nation did not reach this country; that many remained behind in order to aid and assist that great body of their people which had not crossed the Namaesi-sipu, but had retreated into the interior of the country on the other side on being informed of the reception which those who had crossed had met with, and probably thinking that they had all been killed by the enemy.

The tradition continues further, but is not essential to this inquiry except so far as it shows that the Lenape finally spread themselves into the eastern states, establishing new tribes, and into Virginia and Maryland, and states that these younger offshoots recognized their relationship by calling the Lenape their grandfathers, this proving a confirmation of the recentness of the southern Algonquian tribes.

Several important conclusions can be drawn from this tradition, should it be accepted as mainly based on fact. First of all it should, however, be remarked that the well-known Iroquois were never on the Mississippi River in any such war. Either some other river must be understood, or it must be presumed that the alliance with the Mengwe was an event of the later part of the war, and that in the relation it was not sufficiently indicated that the Lenape waged alone a long war of aggression against the Allegewi and drove them from a large part of their domain before the Iroquois tendered their services. The latter alternative is the more probable, since the Huron-Iroquois have only been known as an eastern nation, and since the legend would not so many times mention the Mississippi by name unless there was a grounded conviction in the mind of the narrator, which seemed not likely to be misunderstood, that the Mississippi was crossed by the Lenape.[5]

We may reasonably infer from this tradition, in the light of what we know from a study of the mounds and their characteristic distribution:

1. That the Lenape struck the then mound-builders in southeastern Minnesota and northeastern Iowa, in the region of the effigy mounds, these earthworks being admitted by all to be older than the great mass of the small tumuli of the Mississippi Valley.

2. There was a period of interruption in the war during which the aggressors rested and dwelt peacefully in the land which they had won.

3. On the resumption of the war not all of the Lenape participated, but some remained on the banks of the Mississippi. These may have become known later as the Kaskaskia, Kikapoo, Illinois, Miami, and further south, the Shawnee. It is distinctly stated that a large body

[5] Since this was written the old Dutch map of unknown date has been discovered showing "Iroquoysen" in the region of northern Wisconsin, and if dependence can be placed on that map the Iroquois (*i. e.*, the Hurons or other tribe of that stock) may have united with the Lenape on the east bank of the Mississippi in Wisconsin, according to the statement of the tradition.

remained, some "beyond the Mississippi," and others "where they left them on this side of the river," in the words of the missionary.

Mr. G. E. Squier (1848) later examined this tradition. He fell into the possession of a series of original manuscripts, "through the hands of the executors of the lamented Nicollet," among which was one by Professor C. S. Rafinesque, which was entitled the "Walum Olum," a record preserved on painted sticks, translated by Rafinesque from the original symbols and the Algonquian words written along with them by some interpreter who understood both.

Omitting those portions relating to the creation of the earth, to the deluge and the running off of the waters which show the effects of contact with the European missionaries, I will briefly mention the views of Mr. Squier and the points of coincidence or divergence from the rendition of Heckewelder. Mr. Squier says:

> The details of the migrations here recounted, particularly so far as they relate to the passage of the Mississippi and the subsequent contest with the Tallegwi or Allegwi, and the final expulsion of the latter, coincide generally with those given by various authors, and well known to have existed among the Delawares.

According to the Rafinesque rendition, as given by Squier, there were two great wars. The first was after a migration from the north to the south, attended by a contest with a people denominated Snakes, who were driven toward the east, and the Lenape remained for a time in their land, and multiplied and spread toward the south to a beautiful land which is also called "big-fir" land. In consequence of drouth they move again south into the buffalo land. Here they dwell for some time, when finally their chief leads them toward the rising sun and they arrive at the "Messisipee" or the Great River, the Mississippi, when they stop; but they soon descry the Tallegwi and make war upon them. This war continues through the lives of several chiefs, but ends by the expulsion of the Tallegwi who were driven southward, the victors taking possession of the land where they resided and flourished under a long succession of chiefs. Here they built towns and planted corn, and here, after the expulsion of the Allegewi, is the first mention of the Iroquois, and instead of being their allies they are enemies. They are called Talamatan and Mengwe.

Then commences, apparently, a repetition of the same narration in different words and more in detail, a characteristic feature of many ancient records and legends. In this account, the Lenape departed from a northland, where it was cold and froze and stormed, and they went south to possess milder lands abounding in game. They hunted in all directions and came to the Snake land, whose inhabitants fled

in great fear.[6] The pursuers passed over a hard, stony and frozen "sea," and came to the land of fir trees, which they called "Shinaki."

After the lapse of an indefinite time, during which they remained in the land of firs and came into hostile contact with several of the surrounding people, among whom are Chiconapi, Makatopi, Akonapi and Assinapi, they passed "over a hollow mountain" and found food in the plains of the buffalo land, along a yellow river, where they built towns and raised corn, and remained for a long time, under a number of different chiefs.

Becoming dissatisfied, they "longed for the rich east-land," and on moving in that direction they came into conflict with the Tallegewi. "The Talamatan and the Nitilowan all go united" (to the war); and fell upon and slew great numbers of the Tallegewi. Sometimes they were repulsed by the Tallegewi, but finally all their towns were captured and they fled to the south, and the Talamatan (Hurons?) settled north of the lakes, the Lenape on the south side, *i. e.*, in the land of the Tallegewi.

The rest of the chronicle pertains to later movements in Pennsylvania and New Jersey and their early dealings with the English.

According to both these renditions, all those events preceding the crossing of the Mississippi may have taken place, and probably did, in the region extending from the Hudson Bay southward to the northern boundary line of Iowa, or some miles farther south. The Snake land is problematical, but seems to have been in Canada. The crossing of the frozen water may have been the crossing of the Rainy Lake, or some of the contiguous waters. Shinaki, the land of firs, is the pine-clad region of northern Minnesota. The Assinapi could not have been the Dakota Assiniboins, but may have been some Indians living in the same rocky region.[7] The Buffalo land may have been the southern part of Minnesota and northern Iowa. The "Yellow" River, where they raised corn, may have been that which by the early French was called "La Jaune riviere," now known as Vermilion River, uniting with the Mississippi a little below Hastings, and it is probable that the Tallegewi, as before, were the effigy-builders of the Wisconsin-Minnesota-Iowa region of the old mound-builders. Their movements through the

[6] The term "Snake" here may mean nothing more than *enemy*. The Algonquian termed the Iroquois *snakes*, also the Dakota, applying to them the term *Nadoue*, or *Nadoway*, or finally *Nadouessi*. The last became with the French *Nadouesioux* and with the English *Sioux*.

[7] The Algonquian words *asin* and *bwan*, from which the term Assiniboin is derived, simply means *stone people*. It is commonly supposed to have reference to the use of heated stones by which they made water sufficiently hot to cook food. But instead it may more probably be referred to the characters of the country in which they lived, which was called by Nicolut the "region of rocks and water." The cooking of food by water heated by stones was not peculiar to them.

country east of the Mississippi, according to one of these renditions, was marked by the friendship and later by the hostility of the Talamatan.

It remains to notice one more interpretation of this tradition, that of the late Dr. D. G. Brinton. On a previous page has been given the arrangement which Dr. Brinton presents of the tribes of the Algonquian, having the Cree dialect, which is that characteristic of the region of northern Minnesota and thence northward to Hudson Bay, at the head of the list. Dr. Brinton remarks of this:

> The dialects of all these were related and evidently at some distant day had been derived from the same primitive tongue. Which of them had preserved the ancient forms most closely, it may be premature to decide positively, but the tendency of modern studies has been to assign that place to the Cree, the northernmost of all.

Accepting this indication for what it may be worth, it certainly points to the Cree, or Kilistino, as being not only more nearly connected geographically with the primitive habitat of the Algonquian, but also as representing their ancestors' tongue more nearly than any other dialect of the Algonquian stock. This will allow the post-glacial migration of that stock from the southwest, as has been supposed, perhaps from Colorado and Wyoming, where they seem still to have a representative in the Arapahoe. The Cheyenne who are now associated with the Arapahoe are later comers, having joined the Arapahoe from the northeast within the historic period. On this supposition, the dialect of the Arapahoe would prove, on close comparison, to be more archaic than all other Algonquian dialects, holding for that stock the same position as that held for the Siouan stock by the Catawba dialect in South Carolina, and the late researches of Kroeber bear out this presumption.

As to the tradition itself, it should be premised that Dr. Brinton, along with Horatio Hale, had a belief that the American aborigines had all migrated from the Atlantic coast westward, having reached America from Europe, derived perhaps from some obscure people in the northern part of Spain. Mr. Hale, who seems to be the chief supporter of this view, in referring to migrations of the Indians quotes only historic movements, which certainly have been largely westward, due probably to the encroachments of the whites since the Columbian discovery. It is simply a geographical and historical accident that we are more familiar with the migrations of the eastern Indians than we are with the western. Under the influence of this preconceived idea, which, according to Mr. W. M. Beauchamp, was based on simply a linguistic "likeness" to one or more of the Indian tongues, Dr. Brinton has taken, it seems to me, great liberties with this tradition, inso-

much that he has reversed the direction of the main movement, making it westward instead of eastward, thus making it conform to the direction of historic migrations, with which he seems to think it should be made to agree. He supposes the Lenni-Lenape "at some remote period dwelt far to the northeast, on tidewater, probably Labrador. They journeyed south and west till they reached a broad water full of islands and abounding in fish, perhaps the St. Lawrence about the Thousand Islands." This is quoted verbatim from Dr. Brinton. With similarly violent alterations from the legend, the Lenape are carried into Ohio and Indiana and thence back again to northern New York, having united with the Talamatan (Hurons) to drive out the Talega or Cherokees from the upper Ohio, which they only succeeded in doing finally in the historic period. These alterations from the sense of the tradition, as formerly understood, he claims to be warranted by the discovery of errors in the earlier translations.

The Snake people are relegated to myth, perhaps with correctness. He thinks the legend here relates a conflict between the Algonquian hero-god and the serpent of the waters, a myth which is found also among the Iroquois. After the conclusion of this conflict, the people found themselves in a cold northern country, whence they departed in search of warmer lands. Not recognizing the repetition in the legend of the same story, Dr. Brinton has the Snake war continue on through, and after, the settlement in Shinaki or the "land of spruce pines." Then comes the Lenap 'Allegewi war and the possession of the conquered country.

Neither time nor your patience would warrant me in entering upon a detailed consideration of the validity of the changes introduced by Dr. Brinton. I have carefully examined some of them that have some geographic relation to the country concerned, and will mention only that relating to the so-called "Yellow" River, where, according to the legend, the Lenape dwelt and raised corn "on a stoneless soil." Dr. Brinton considers this stream (Wissawanna) a small river in Indiana, a branch of the Kankakee, saying that on Hough's map of Indian names of Indiana that word has been corrupted to "Wethogan," and that the Minsi, one of the Lenape sub-tribes, were found there in 1721 by Charlevoix, and that they made their first migration from the east about 1690. This involves a historical anachronism, inasmuch as it makes an event occurring in 1690 to 1721 explain a doubtful point in a legend which is wholly confined to prehistoric time. If the Yellow River was first named in 1690–1721 it is not likely to have had that name when the Lenape were waging their war in prehistoric time before they had yet settled in New Jersey. Again the region is said to have a "stoneless soil," which could hardly be affirmed of northern

Indiana.[8] But if the reference of the tradition to a "Yellow" River be not to the Missouri, as has been supposed by some, there is a Yellow River in Minnesota, if another is needed, viz., that now called Vermilion River, entering the Mississippi below Hastings, which, indeed, has a stoneless soil. From there southward extends the "driftless region" on the east of the Mississippi, and in that vicinity are the first of the effigy mounds, *i. e.*, in the Cannon Valley and in Goodhue and Wabasha counties and extending southward, while on the east side of the Mississippi is the central and most characteristic region of effigy mounds. It is not at all improbable that the migrating Lenape made a long halt in the valley of the Vermilion, contiguous to these mound-builders before they entered upon the great war.

This is the first of the great legends to which I called your attention. The second is that which brought the Dakota tribes into Minnesota, and it doubtless pertains to a time nearly cotemporary with that which refers to the Lenape. It comes to us from the other party to the great conflict, and it no doubt refers to the consequences of the Lenape invasion. This legend is found amongst several of the Dakota tribes, and even amongst the later Algonquian who returned westward to the Mississippi Valley. I will not dwell on the details with those separate tribes, but simply mention the tribes with which it has been handed down from generation to generation, viz., Osage, Omaha, Mandan, Kansa and Akansea, and Ponca. These tribes concur in saying that they formerly dwelt in the Ohio and Wabash valleys, and that they moved down the Ohio Valley, where they were separated into two divisions at the mouth of the Ohio River, some of them going down the Mississippi and some of them up the same river. They repeated such segregation at the Missouri, where, as it appears from the preservation of the name, the Mantane divided into two parties, one of which became the Mandans and the other the Mantanton, the latter being one of the tribes of the Issanti at Mille Lac in 1701 when these tribes were enumerated by Le Sueur, at Fort L'Huillier. The name Issati or Isanti, is itself, apparently, another form of a name of the Siouan South Carolinan Santee, and sometimes, even now, it reverts to the original spelling. If so, they preserved their name during their long residence in the Ohio Valley as moundbuilders.

This tradition is linked in with some historic data in about the same manner that the Lenape migration is linked, and verified by some scant connection with historic events. With this migration the territory of Minnesota was almost wholly occupied by the Siouan stock, and

[8] According to Leverett's late description of the valley of Yellow River in Indiana, the lower reaches of the valley have a sandy loam soil in which the drainage is very imperfect, and the valley for fifteen miles above its union with the Kankakee is narrow. Above that point the Yellow River drains a stony region comprised in the Maxinkuckee moraine. *Ill Glac. Lobe*, p. 507; *Mem. U. S. G. S.*, XXXVIII.

that stock controlled it till the last incursion of the Ojibway from Lake Superior, when, with the great battle of Kathio, another culminating event of the hereditary war took place. This brings us to recent time in Minnesota and it is not necessary to enter upon later tragic events.

There is still, however, one other point to which I wish to refer, viz., in coming to Minnesota those mound-builders who ascended the Mississippi above the mouth of the Wisconsin River returned to their former home. They may have recognized it as the scene of their first defeat by the Lenape, and probably some of them remained there and resumed the construction of mounds. It is admitted by all who have given attention to the subject that the effigy mounds are of a class distinct from and older than the tumuli that are scattered amongst them and which prevail in Minnesota and Dakota. The Winnebago may have been effigy-builders when the Lenape crossed the Mississippi. If so, they must have fled northward from their enemies, instead of southward, and thus escaped the fate of their kindred. They perhaps remained in southern Wisconsin during the whole Lenap'Alligewi war, and so probably welcomed the fugitives on their return. This may account for that curious geographical extension of the Dakota stock on the east of the Mississippi in a narrow tongue reaching Lake Michigan; and it also accounts for the fact that linguistically the Winnebago dialect is one of the oldest of the Siouan stock found in the upper Mississippi region; and further, that the Winnebago are called "grandfathers" by the other tribes.

Thus it appears that the mound-builder dynasty was divided into two parts by a great national misfortune. The Ohio dynasty endured a long period of time. It was probably coeval with the effigy mound-building period or closely followed it. The Minnesota dynasty is comparatively recent, and was short, at the utmost not exceeding 500 years, and extended down to the incoming of the whites.

In conclusion, I can make the merest reference to another prehistoric migration affecting Minnesota, of later date than the preceding. It is well established by coherent and reliable tradition that the Hidatsa Indians, associates of the Mandans on the upper Missouri, also called Minnitari, of the same stock as the Mandans, migrated from Minnesota across the prairie and settled with the Mandans.

We see then that the succession of dynasties in Minnesota is as follows:

1. Algonquian (small area in the southeast also held by the Ohio mound-builders).

2. Siouan, fugitives from Ohio (establishing the Minnesota dynasty of mound-builders).

3. Ojibwa (Algonquian) incursion from Lake Superior, dividing the state with the Siouan people.

4. Aryan civilization.

THE MOVEMENT TOWARDS "PHYSIOLOGICAL" PSYCHOLOGY. IV

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VI

NOW that Herbert Spencer and Eduard von Hartmann have passed away, Wundt stands almost alone among living thinkers. The importance of his philosophical contribution ranks second only to his epoch-making career in psychology. Time forbids more than this reference to it; but I may add that, very likely, his philosophical attitude possesses a future. For he heads a rising school which holds that a main business of philosophy in present circumstances is to unify and systematize the manifold results garnered piecemeal by the positive sciences.

Born in 1832, Wundt began his academic career as a medical student at Heidelberg in 1851, and continued the same studies later at Tübingen and Berlin, where he resided at the close of Johannes Müller's professorship. In 1856 he worked for a year in the physiological laboratory at Heidelberg under Helmholtz. On the scientific side he came under the influence of Müller, Fr. Arnold (in anatomy), Hasse (in pathology), E. H. and W. Weber, Helmholtz, Lotze, Bain and Fechner. Early in life he also made acquaintance with the philosophical work of Leibniz, Kant, Herbart and Lotze. As stated above,[1] he records that, in psychology, he owes the largest debt to Kant and Herbart; this explains not a few of his later positions, especially those to which younger men, of purely experimental training, have taken exception, without over-much appreciation sometimes, I fear, of what exactly they opposed. His life-work as a teacher and investigator has lain at Zürich, and Leipzig, whither he was called in 1876, and where, in 1879, he set up the first purely psychological laboratory,[2] an example followed since by many of the great universities in all civilized lands. Unlike his predecessors, especially Weber, Helmholtz, Lotze and Fechner, he has not concentrated his attention upon this or that restricted group of psycho-physiological phenomena, but has ranged over the entire field, with the result that psychology owes to him at once

that ever enters high school.

[1] Article I.

[2] I am not forgetting James's laboratory at Harvard in 1875, which was physiological.

its present systematic form and its definite place in the fellowship of the special sciences. For these reasons, his influence and methods have penetrated everywhere.

A bare list of his principal works suffices to exhibit the range and force of his tireless activity: "Beiträge zur Lehre von den Muskelbewegungen," 1858; "Beiträge zur Theorie der Sinneswahrnemung," 1859–62; "Vorlesungen über die Menschen- und Thierseele," 1863, 2d ed., 1892 (Eng. trans.); "Grundzüge der physiologischen Psychologie," 1874, 5th ed., 1902 (Eng. trans.); "Ueber die Aufgaben der Philosophie in der Gegenwart," 1874; "Ueber den Einfluss der Philosophie auf die Erfahrungswissenschaften," 1876; "Logik," 1880–83; "Ethik," 1886, 2d ed., 1892 (Eng. trans.); "System der Philosophie," 1889; "Grundriss der Psychologie," 1898 (Eng. trans.); "Völkerpsychologie," 1900–06; and many contributions of first-rate importance to *Philosophische Studien*, the organ of his laboratory and philosophical circle, since 1881, the first year of its publication. When we remember that four of these books are masterpieces, and that one of them is *the* recognized classic in its subject, some idea of Wundt's importance emerges.

Seizing the opportunity incident to his historical position, Wundt aimed to relieve psychology from the reproach of being merely an instance of more or less loose *descriptive* classification. He proposed to lift it to the level of scientific *explanation*. By what means?

> It is experiment that has been the source of the decided advance in natural science, and brought about such revolutions in our scientific views. Let us now apply experiment to the science of mind. We must remember that in every department of investigation the experimental method takes on a special form, according to the nature of the facts investigated. We can not experiment upon mind itself, but only upon its outworks, the organs of sense and movement which are functionally related to mental processes. So that every psychological experiment is at the same time physiological, just as there are physical sciences corresponding to the mental processes of sensation, idea and will. This, of course, is no reason for denying to experiment the character of a psychological method. It is simply due to the general conditions of our mental life, one aspect of which is its constant connection with the body.[3]

Or, again:

> Psychology is compelled to make use of objective changes in order, by means of the influence which they exert on our consciousness, to establish the subjective properties and laws of that consciousness.[4]

Or, once more:

> Physiological psychology is, therefore, first of all *psychology*. It has in view the same principal object upon which all other forms of psychological investigation are directed: *the investigation of conscious processes in the modes*

[3] "Human and Animal Psychology," p. 10 (Eng. trans.).

[4] *Philos. Studien*, I., p. 4.

of connection peculiar to them. It is not a province of physiology; nor does it attempt, as has been mistakenly asserted, to derive or explain the phenomena of the psychical from those of the physical life. We may read this meaning into the phrase "physiological psychology," just as we might interpret "microscopical anatomy" to mean a discussion, with illustrations from anatomy, of what has been accomplished by the microscope; but the words should be no more misleading in the one case than they are in the other. As employed in the present work, the adjective "physiological" implies simply that our psychology will avail itself to the full of the means that modern physiology puts at its disposal for the analysis of conscious processes.[5]

But, had he gone no farther than this, Wundt could scarcely be excepted from the condemnation of his predecessors, or from that under which some of his scholars have fallen. For, plainly, it could be objected that he had omitted the two most remarkable facts of consciousness which, stated synoptically, are its *intensive* or individual centralization, and its *extensive* development in society. These aspects of the matter tend to get beyond psychological management, as they assuredly raise ultimate philosophical problems. Wundt's high distinction is attributable mainly to his recognition of and attack upon these difficulties. So, his psychology offers a second, and broader, side, set forth, for example, in his excursus entitled "Philosophie und Wissenschaft" ("Essays," 1881), and present as a constructive, possibly a disturbing, element, in his entire purview of the psychological field. For instance, in his "System," the theory of the "growth of mental values" bears precisely upon these questions. "Mental life is, extensively and intensively, governed by a law of growth of values: extensively, inasmuch as the multiplicity of mental developments is always on the increase; intensively, inasmuch as the values which appear in these developments increase in degree."[6] And, on the strictly psychological side, he takes note of the same things as follows:

We may add that, fortunately for the science, there are other sources of objective psychological knowledge, which become accessible at the very point where the experimental method fails us. These are certain products of the common mental life, in which we may trace the operation of determinate psychical motives; chief among them are language, myth and custom. In part determined by historical conditions, they are also, in part, dependent upon universal psychological laws; and the phenomena that are referable to these laws form the subject-matter of a special psychological discipline, *ethnic* psychology. The results of ethnic psychology constitute, at the same time, our chief source of information regarding the general psychology of the complex mental processes. In this way, experimental psychology and ethnic psychology form the two principal departments of scientific psychology at large. They are supplemented by *child* and *animal* psychology, which, in conjunction with ethnic psychology, attempt to resolve the problems of psychogenesis. . . . Finally, child psychology and experimental psychology in the narrower sense may be bracketed

[5] "Physiological Psychology," Vol. I., p. 2 (Eng. trans.).

[6] "System der Phil." (2d ed.), p. 304.

together as *individual* psychology, while animal psychology and ethnic psychology form the two halves of a *generic* or *comparative* psychology.[1]

So far the *extensive* development. On the side of *intensive* centralization Wundt's doctrine of apperception provides the necessary hypothesis. To these aspects of the subject I can only refer now.

Turning at once to the "Physiological Psychology," we find that it proceeds, as scientific method dictates, from the simple to the complex. After an introduction, Part I. discusses the bodily Substrate of the Mental Life; Part II. the Elements of the Mental Life; Part III. the Formation of Sensory Ideas; Part IV. the Affective Process and Volitional Action; Part. V. the Course and the Connection of Mental Processes; Part VI. adds Final Considerations. Thus, we pass from the functions of the nervous system, by way of sensation, feeling and presentation, to consciousness in the formation of ideas and in the train of ideas, which, in turn, involves attention, apperception, and will, not forgetting phenomena such as association, imagination and emotion. Two reasons make it hard to select this or that, and to say, Here Wundt excels. First, profuse wealth of suggestion and result is scattered everywhere. Second, the successive editions of the "Physiological Psychology" constitute the life history of Wundt's own mind in relation to the subject as a whole; and only psychologists *von Fach* can supply the necessary light and shade. It appears to me that special interest attaches to his discussion of Müller's theory of specific energies, because it reveals Wundt's view of the part played by the nervous system in the psychological organization; to his criticism of the Young-Helmholtz theory of color, because it attacks the "mystery" of space-perception; to the treatment of sensation, the duration of mental processes, and association, because they afford typical instances of the new data which experimental psychology can bestow upon analyses of psychical phenomena. Doubtless, professed psychologists would insist upon other points. For my part, the central interest still attaches to Wundt's theory of apperception and will. I take the former as a typical illustration of the *direction* in which physiological psychology moves.

In apperception the conscious being brings his entire unity of experience to bear on the object now in the field of his attention. We light upon an inner and elaborative activity which "bears the stamp of spontaneity." Evidently, a process complex in the highest degree! My expert colleague, Professor Pillsbury, has analyzed it as follows: Apperception involves four elements. "(1) Increase of clearness in the idea directly before the mind, accompanied by the immediate feeling of activity; (2) inhibition of other ideas; (3) muscular strain sensations, with the feelings connected with them, intensifying the

[1] "Physiol. Psych.," Vol. I., pp. 5–6 (Eng. trans.).

primary feeling of activity; (4) the reflex effect of these strain sensations, intensifying the idea apperceived."[8] Despite this complexity, the apperceptive theory posits fundamentally a necessary "original activity," or "psychical energy," which arises from within consciousness and transforms, as by a synthesis, what, for convenience sake, may be termed simple factors. Physiological stimulus pales, and subjective transitiveness becomes determining. This activity has close connection with will, often with choice. How can it be explained? With Wundt the term consciousness possesses a special and restricted meaning. It consists of all contents, such as feelings, ideas, excitations of the will, and—there is *no underlying substance or occult being.* This represents the analytic aspect; the synthetic remains to be reckoned with. Now, the spontaneous activity of the mind itself, whereby presentations come to be distinguished clearly, appears as *appercipient attention,* when brought to play upon perceptions or upon the "stream of consciousness," and as *volition,* when it originates movements of the body. Obviously, the former is the more fundamental, because, in it, I connect my ideas with my will. It "depends, on the one hand, upon the stimuli then at work; and, on the other hand, upon the total state of consciousness, how it is made up that is, by present impressions and prior experiences. . . . If we would describe more nearly what it is that we experience in ourselves when pleased or pained we can not do this more concretely than by denoting pleasure as a straining after, and pain as a straining against, an object."[9] We may say, then, that apperception means will brought to bear upon states of consciousness and then directed to external muscular acts. For, "there is absolutely nothing outside man or in him which we can call wholly or entirely his own except his will."[10] So Wundt finds the existence of a synthetic activity of consciousness *beyond the range of mere association.* Without going far wrong, we might term this the single faculty into which all the faculties of the old psychology are absorbed. For it compares and selects among conscious states; or peradventure, it can be described as a species of conscious striving. Here, then, the mental unity presents its distinctive, differentiating nature, and, as some have indeed supposed, might be held exempt from the persistent sapping of psychophysiological method, secluding itself within its unattainable citadel. But this is a complete mistake; and I take the opportunity to call attention to Wundt's modern position even here, a pronouncement the more necessary that he has been so frequently misunderstood, strangely enough, by those who ought to know better. Apperception, or what you please, happens to be an undoubted fact of mental life. Accord-

[8] *Am. Journal of Psych.*, Vol. VIII., part 3.
[9] "Physiol. Psych.," p. 535, Vol. I. (3d ed.).
[10] "System d. Phil.," p. 387.

ingly, it must submit to experimental treatment. A process exists, therefore analysis is free to track it to its lair. And, especially when the problem of duration raises its head, as it does inevitably, a cumulative series of experiments is in strict order.

What happens when apperception occurs? Generally, of course, a transformation of sensory into motor activity. In detail, according to Wundt, a train of processes has supervened, *viz.:* (1) Transmission from the sense-organ to the brain; (2) entrance into the "field of view," that is, existence of simple perception; (3) entrance into the "point of view," when perception becomes discernment; (4) activity of will, with innervation of the central organism through the motor-nerves, and (5) the resultant excitation of the muscles. Plainly, the crux hides in (3), which is purely psychological, while the others have a clear physiological reference. Nevertheless, (3) happens to be so surrounded by physiological phenomena that it is open to observation and experiment and these methods have been concentrated upon a research into the cerebral changes which accompany perception, apperception and will, respectively.[11] These experiments, although elaborate, and becoming more elaborate, may be classed under three heads. (1) The investigation of simple physiological time, that is, when the subject is aware of the coming impression, but is ignorant just when it will take place. (2) Those in which even this element of ignorance is eliminated. (3) Those in which modifications are possible widely, because, for example, the subject does not know what the impression will be, or is unaware of the character of the stimulus in such a way that he does not know how precisely he will be called upon to register it. In combination, these experiments show, as Wundt infers, that the exact moment of appercipience is dependent upon the self-accommodation of the subject, particularly in the matter of attention. Take the third case:

> An indicator is kept moving at a uniform rate over a graduated scale, and so situated that the place of the needle can be clearly seen at each instant of time. The action of the same clock which moves the needle causes a sound at any moment, but in such a way that the subject of the experiment does not know when to expect it. With what position of the needle, now, will the sensation of sound be combined? Will the sound be heard exactly when it occurs, as indicated by the needle; or later than its real time ("positive" lengthening); or earlier than its real time ("negative" lengthening)? The result shows that one rarely hears the sound without either positive or negative displacement of it; but most frequently the lengthening is negative—that is, one believes one hears the sound before it really occurs as measured by the indicator.[12]

In this connection, then, the fundamental problem of physiological

[11] Cf. Cattell in *Mind*, XIII., pp. 37 ff. (old series), and Titchener in *ibid.*, I., pp. 206 ff. (new series).

[12] "Elements of Physiological Psychology," Ladd, p. 488.

psychology is, "to determine the simple reaction-time, and from it to find the factors of psycho-physical time—namely, perception-time, apperception-time (or discernment-time), and will-time."[13]

Along this line laboratory investigation has been able to show that the will does, as a matter of record, occasion changes in the central physiological mechanism, and that these changes possess *quantitative* differences having more or less definite relation to psychical activity. By this I understand that the latent energy of the nerve-cells is summoned to activity, and that, as a result, the brain labors hard. In our own laboratory I have seen the subject of an attention experiment pour with perspiration, although physically he was, to all appearance, quite quiescent. No better proof of intense cerebral work could be desired. And experiment simply attempts to relate this energizing to the concomitant psychological states.

But Wundt has committed himself to the modern attitude even further. In the first and second editions of his "Physiological Psychology," he suggested that the frontal regions of the brain are related to apperception as the "bearers of the physiological processes which accompany the apperception of the presentations of sense."[14] In other words, all stages of the apperceptive process are accompanied by a fixed physiological activity. Beyond the circumstance that this assigns a function to the frontal regions which, otherwise, stand out of distinct relation to the factors of consciousness, it must be regarded as a speculation. Wundt himself, although he does not dismiss the hypothesis, tends to minimize it from his third edition. Yet it serves to show how persistently he clings to the true psycho-physiological method even in regard to the most recondite operation of the mind.

It remains to note that the influence of mind over body demands study as much as the converse. If apperception be a legitimate supposition—and it would seem to be a hypothesis which at least accounts for unquestioned facts, then it follows that we must estimate it, not by external stimulus, but in terms of internal activity. And this, of course, reminds us that psycho-physiological investigation has proved the existence of an influential voluntaristic element. No doubt, to this point, the former has claimed, and still claims, the lion's share of experimental attention. So that, in many ways, the internal problem awaits concentrated attack. That is to say, physical and physiological problems, being so much more readily amenable to the new methods, have tended to crowd out the distinctively psychological material. Nevertheless, we have arrived at something *analogous* to a *causal* influence of the central nervous system upon what I shall call ideation. This was the indispensable initial step. But yet, this causality is

[13] *Ibid.*, p. 472.

[14] Second edition, Vol. I., p. 218.

necessarily in consciousness, and, in so far forth, is not causal at all. For, of nervous states as such we do not know anything, and never can know anything. Accordingly, the other side proffers its claim, which, in the light of this agnosticism, is very far from being modest. This point was admirably taken by Professor Cattell, in his vice-presidential address to the Anthropological Section of the American Association for the Advancement of Science, in 1888:

> Much is being written just now regarding the relation of consciousness to the brain. The question is: Do perceptions, thoughts, feelings, volitions, stand in causal interaction with the brain, or are they an epiphenomenon, accompanying changes in the brain but not influencing them? Are our ordinary actions complex reflexes due to physical stimuli and the structure of the nervous system, or are the changes in the brain that precede movements initiated and directed by consciousness? The question is one of facts that should be settled by scientific methods; and the solution will by no means concern psychology alone. The two greatest scientific generalizations of the present century are the conservation of energy and evolution by the survival of the fit. Now, if consciousness alters, however slightly, the position of molecules in the brain the fundamental concept of physical science must be abandoned. If consciousness have no concern in the actions of the individual we have one of the most complex results of evolution developed apart from the survival of useful variations, and the Darwinian theory has failed.[15]

We conclude then with the startling reflection that psychology is the keeper of a tremendous oracle. And, on the whole, the oracle keeps silence still.

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[15] P. 12.

THE PRACTICAL VALUE OF PURE SCIENCE

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THROUGH all ages men have asked, What is worth while? The answer has been, at least from those not stupefied by pessimism, that many things are worth the while: happiness, self-respect, health, friendship, honor, wealth, all these are worth having, and any work that helps to secure them deserves the undertaking. It is the old question of what man should try to attain, and about it many a system of philosophy has reared itself, though for the most part on shaking legs.

Through this conflict of opinion we have come to pride ourselves upon being practical, even to such an extent as to consider abnormal any one who does not share this quality. To be practical means to be able to turn knowledge to useful account, to make of it some rather immediate application. With us Americans to be practical means too often to make and save money, forgetting that money is only a tool. Personally I would hold that man to be most practical who gets the most happiness out of life. But at the present we are concerned only with the question, that may seem a paradox, how can pure science be a practical undertaking?

Science in the strict sense, or pure science, is the search for the explanation of things. It is not the collecting of statistics, nor the cataloguing of them, nor the construction of systems, for however much these operations may help science, they do not compose it. Science is the light that points out what different phenomena have in common, and establishes their origins and changes. To-day the term is often taken in vain, as when we speak of pugilistic, tonsorial and domestic science, which shows that the general idea of it is any special skill or knowledge. But pure science, as strictly used, is much more than either skill or knowledge, it is explanation without any thought of immediate application to human needs.

How, then, is pure science practical, when it avowedly seeks no quick useful end? It is so, as its records show, by serving as the pioneer that makes possible utilitarian ends, it breaks a road through the unknown for application to follow. For not until science has given the explanation can we turn that explanation to use. And the examples that I shall proceed to relate show clearly that the pursuit of pure science has made possible many of the benefits that we now enjoy.

It would be well worth while to stop to consider how much the various branches of engineering owe to pure mathematics and pure physics; or to relate the rise of numerous great industries that have grown out of the theoretical study of chemistry. Where would be our electric lighting and transportation but for the explanations of Franklin, Volta and Faraday? But I will limit myself to the practical value of pure science as exemplified by a particular one, biology. In making this restriction I should add that history tells how each of the pure sciences has led to useful ends, so that biology is but one of several cooperating sisters, each making her contribution to greater human happiness.

Biology has to explain the nature of living energies in treating of animals and plants and of man himself. Biology has to interpret processes, and this it attempts to do in a variety of ways according to the nature of the problem, the material and the bias of the thinker. Biology has to some extent grown up side by side with medicine; each helped the other in the days of their beginnings, and for that reason we may first treat its practical bearings to medicine.

In the seventeenth century the microscope came into use and it opened up, in the hands of Leeuwenhoek and Schwammerdamm, a wealth of unexpected detail. Leeuwenhoek exhibited his dissection of an ant to the delighted eyes of a king; since that time the tastes of royalty seem to have deteriorated. But such discoveries in the finer details of anatomy only presented new problems. The partial explanation came in 1838 with Schleiden and the following year with Schwann, who stated that animals and plants are built up of definite living units, the cells; that such units compose the tissues that had been determined by the physiologist Bichat, and that the organs are composed of definite layers of cells. The simplest animals, what we now call the Protozoa, were shown by Dujardin to be each composed of only a single cell. We define a cell as a particular mass of living substance regulated by a particular center, the nucleus. This view was strengthened by the notable researches of particularly von Kölliker and Max Schultze, and so gradually extended to all animals and plants as well as to the human body. Eduard van Beneden later finally settled the fact that the egg, the beginning of each many-celled animal, is itself a single cell. Thus biologists have come to concentrate their attention upon cell activities, and this cell unit has proved as fruitful in biology as the atom in chemistry, though the cell is something vastly more complex than many atoms. Now there grew up with this new doctrine Rudolf Virchow, the great master of the study of disease, and he it was who by placing the study of disease upon the cellular basis, by tracing diseased conditions to particular cells, laid the rational foundation of one branch of modern medicine. The investigation of the

structure and function of cells is to-day regarded as the basis of research in medicine as well as in biology. Yet all of it is traceable to the dissection of an ant beneath a crude microscope! Surely nothing would have seemed less likely to have had practical bearings.

Such studies have given also the basis for embryology, the analysis of the development of the individual. Perhaps the greatest marvel of nature is the growth and change of the individual, a process that is ever before us, yet considered by few. From a microscopic egg cell that shows but few differences in its various parts, grows up the adult body with its manifold organs; hairs and muscles, bones and lungs, these are not present as such in the egg cell, yet they gradually arise out of it and in the order of their use. The problem is: is such development regulated by energies of the egg cell, or by the operation of new stimuli and energies as the development proceeds? The marvel is the astounding precision of the process in spite of its complexity. When you eat your morning egg glance at the yellow yolk ball and note at one point of its surface a small white disc; that is the egg cell proper, all the rest is simply food for it. Now try to think out how that little disc produces the complex fowl, and you will agree that the problem is a much harder one than the fluctuations of stocks in your morning paper. This problem has also a close bearing on medicine, as William Harvey pointed out some three centuries ago and more, for the development of the human body is as important to the physician as its anatomy, because the anatomy is but one view of the individual, while the development represents the whole. To understand our own bodies we must know how they are formed, and to understand disease it must be traced to its origin. The changes from the egg cell to the adult demonstrate that the longer a part develops, the more precise and fixed it becomes, so that finally each particular part comes to have one definite structure, position and use. Malignant growths, then, probably have their causes most frequently early in development, due to misplacement of cells, temporary arrest of growth, undue rapid multiplication of cells, and other abnormalities. But this is not the place to attempt to classify diseases on an embryological basis, such as has been done by Minot. We need note here only that medicine is beginning to tread in the path made by biology, in recognizing that human disease as well as human anatomy must rest on the foundation of development.

Then, to understand our own bodies we have to explain them in terms of the structure of other animals, and many of our parts would be meaningless to us but for a knowledge of comparative anatomy. Our cankered vermiform appendix is represented in some animals by a large and serviceable attachment of the digestive tract, which explains it as a degenerate organ and therefore necessarily variable. Deep

between the hemispheres of the brain is a little sac about the size of a pea, the pineal gland, and comparison shows that this was once a third eye. Sometimes an opening persists on the side of the neck below the jaw; in such a case one of the embryonic neck clefts has remained open, and this in turn has relations to the gill slits of a fish. All the ground plan of our bodies, the muscle cylinder within the skin, next the bony scaffolding, innermost the peritoneal sack around the viscera, all such relations would remain a mystery did we study only the human body. But in the light of comparative anatomy and embryology we recognize them as necessary parts of our heritage. Medicine must stand upon a thorough knowledge of the structure and processes of the human body, and before it can treat disorders it must understand states of health and their origin. Comparative anatomists and embryologists, the great men Harvey, Wolff, von Baer, Cuvier, Agassiz, Huxley, Cope and Gegenbaur, such men have not only broadened the field of human thought, but have also furnished the understanding of the human organism. They were all pure scientists, they did not have in mind the care and cure of the human body. Yet we might say they accomplished more for a rational medicine than all the physicians before them. How unlikely the prophecy seemed that any direct advantage would come to mankind from the researches of Harvey, Wolff and von Baer on the development of the chick, from those of Cuvier and Agassiz on fossils, or from those of Huxley, Cope and Gegenbaur on comparative anatomy. As the result of this change of thought we now see most medical schools prescribing biological courses, and choosing their professors of anatomy largely from the ranks of embryologists.

It is hardly necessary to state that it was Louis Pasteur who laid the foundation for the study of disease-producing organisms; indeed, he may be said to have done more for the human race, more to prevent physical misery, than any other man of the nineteenth century. He had in mind, first of all, the cure, but he realized that to accomplish this the mode of transmission of the disease must be understood. There have followed him a long line of investigators of bacterial diseases, and among them the purely scientific have done quite as much as the purely practical. In Russia there was a celebrated embryologist, Elias Metchnikoff, who worked out the life histories of a variety of animals, and was thereby led to a consideration of the part that the white blood cells play in the development. This brought him to the view that such cells are the guardian policemen of the body, that seek out and destroy the bacteria; and this to the further idea, that health is to be maintained and infection prevented by keeping the white blood cells in proper numbers and activity. Metchnikoff succeeded Pasteur at Paris, and though his theory of phagocytosis is far from all-sufficient, it has nevertheless strongly stimulated the study of bacteriology. His

practical ideas grew out of his theoretical investigations of insects and worms.

Just at the present time the center of interest in medicine is the study of those infectious diseases produced not by bacteria, but by other one-celled germs, the animal protozoa. Among them are the blood parasites that produce malaria, yellow fever, syphilis and the terrible sleeping sickness of Africa, as well as the intestinal parasites of bloody dysentery; another one of them produces the Texas fever of cattle. Many investigators have contributed to our knowledge of these diseases since the time when Laveran discovered the germ of malaria, and prominent among them are the names of Grassi and Schaudinn. Grassi is professor of zoology at Rome, well known for his researches on the ancestry of insects, on the social communities of the white ants and on comparative anatomy; these researches on unpractical subjects furnished him with the method for attacking the malarial germ, and for making the marshes around Rome nearly free from that disease. Schaudinn worked at Berlin on the life histories of salt-water protozoa, discovering much of broad theoretical importance, indeed with much greater success than the long line of naturalists before him. He was no physician, he was a biologist, yet he ultimately attained one of the most desired medical chairs in Germany. His genius, and in a measure he is to be compared with Pasteur, lay in his success in unraveling complex life histories; he learned the method in studying the free-living forms, and therefore was enabled to work out the life histories of several that endanger the human body. He never had any direct interest in practical medicine, yet what help his work has brought to medicine! What he did in this direction, the zoologists Leuckart and Leidy did in another by their discoveries on the parasitic worms of man, and on the mode of infection; they all had little thought of practical application. Such biologists have taught pathologists that in the cure of any infectious diseases the first thing to be determined is the life history of the parasite, and this subject is a biological one.

Besides seeking the prevention of disease man has to meet the natural struggle for existence in another way, by securing food, and this means the nurture of his flocks and crops. Here again pure science has proved a valuable pioneer. Naturalists have long since recognized the close dependence of species upon each other, that what affects one comes in the long run to affect all. This is a dependence based upon the struggle for food. Remove one element, as one species, and a more or less general profound disturbance follows. Mankind is in no way exempt from this law. Decimate or extirpate a particular kind of insect-eating bird, and the insects that formed its diet will increase in numbers. Man will feel the disturbance should such insects happen to affect vegetation that is of human use. Remove the timber from moun-

tain lands, and the available water will decrease, because the timber helps to hold the water supply and to prevent floods. In any way change the face of nature, as man by his habits must needs to do continually, and more or less serious results must follow. As an instance we may consider the cotton boll weevil, a subject that is a remarkably earnest one in Texas. This insect originated in Central America and has spread northward; several years ago the natural barriers to its spread were broken down and consequently it has extended its feeding area. When it first appeared in Texas all sorts of rough remedies were applied, but in vain; then the help of the National Department of Entomology of the Bureau of Agriculture was called in. They responded by sending down experts: not men trained in boll-weevil methods, for these had to be learned, but men with a good knowledge of general entomology, ready to attack the matter as they would any scientific problem. First they proceeded to determine the life history, egg-laying habits, duration of the different developmental stages, number of broods, overwintering; then, knowing these facts, they could decide at what stage the injury may be most successfully fought. The method is of the first importance and this was given by pure science, and in a way the method of meeting the boll weevil is not unlike the method of fighting a parasite of the human body. The next step was to ascertain the natural animal and plant enemies of the pest, and to try to increase these enemies. Thus the field mice in Russia have been reduced by infecting them with pathogenic bacteria, and the "green-bugs" of wheat by increasing the number of lady beetles. These are the general methods of meeting any such practical questions. Farmers may laugh at naturalists, but they are wholly dependent upon them when such emergencies arise. Most of us are likely to smile at the man who collects and describes insects, counting the number of joints in the antennæ of a bug, of hairs upon the forehead of a bee, or the arrangement of the veins upon the wing of a moth. Most people would hold that such a being is wasting his time in a foolish hobby. But I wish to drive the fact very firmly home, that the collecting and naming of animals and plants, occupations that even many biologists pity, are really fundamental for biology and therefore for the sciences that rest upon biology. For the study of animals and plants had reached a standstill, a stagnation, for want of a proper concise method of naming the numerous species that were being made known, until the great Swede Linnæus, in the middle of the eighteenth century, by originating the modern method of naming plants and animals, indirectly made possible advance in agriculture as well as in biology. The more our knowledge advances the greater grows the need of accurate determinations of species. Without systematic describers of species agriculture would be a hopeless matter. Thanks to the labors of gen-

erations of pure scientists, working for the most part in obscurity, most of the insects in each civilized district have been described and named, and much has been made known concerning their habits. This knowledge is about as important a tool to the husbandman as is his plough.

In passing it need only be mentioned that the agitation for the protection of native birds, a movement that the farmers are at last beginning to support, originated not with agriculturists, but with scientific ornithologists. The farmer, left to his own prejudices, would kill all birds.

In another way pure science has aided agriculture, in improving varieties. The chief method in use is selection, planting each new generation from the seeds or cuttings of the best plants of the previous one; the most fit are selected and propagated. This method has been in use for more than a century, but it is only within the past fifty years that it has entered into general systematic employ. The man whose labors brought this method into dominance was Charles Darwin, who proved how important a factor selection is in the perpetuation and guidance of the changes of living beings. Now Darwin was not called a practical man; he was first an insect collector and geologist, then a traveler, lastly a most conscientious experimenter with an eye single to explaining. He discovered a natural factor in evolution, and illustrated it so fully on both wild and cultivated species that the world has accepted its truth. Before him men had applied selection rather unwittingly, on the general assumption that "blood will tell." After him they saw clearly into the workings of the principle, and now experiment with a fixed method. It is Darwin's method that the Department of Agriculture is trying to teach the farmers.

Then much work has been done to secure improvement by the cross-breeding or hybridizing of different varieties. It was Darwin again who was the first broadly scientific investigator of such inheritance. Take two plants or two animals which differ in one or more qualities and cross them, then it is to be expected that the hybrids will differ from the parents, and that a new strain or breed may be obtained that will prove more favorable for our particular purposes. Much of this kind of experimentation, perhaps the greater part, has been done so far by practical animal breeders and gardeners, and it was from such records that Darwin obtained much of his information. No one, for instance, has carried it out more extensively than Burbank, and he has had in mind marketable returns. Yet the theoretical study of hybridizing is coming to aid the other, and in time may come to direct it. Different kinds of inheritance are now distinguished, as blended inheritance, when the hybrid is intermediate between the two parents; mosaic, when it has some of the characters of the one and some of the

other; alternate, when some of the hybrids are like one parent and some like the other; and the so-called unisexual inheritance, when all the hybrids tend to resemble one particular parent. Entirely new and unexpected fields of experimentation have been brought out by Mendel's study of alternate, and De Vries's examination of unisexual inheritance. This theoretical work also teaches that in practise attention should be given not so much to the whole individual as to the particular quality desired. The remarkable work of De Vries, the most important in evolution since the time of Darwin, would tend to show that though new forms may be produced by crossing, such crosses are usually not permanent, but tend to revert. De Vries's particular contention is that stable new forms, those that breed true, are not produced gradually by selection or otherwise, but arise suddenly and only in particular mutation periods. This introduces an entirely new attitude in the matters of selection and cross-breeding, and there can be no doubt that the scientific decision of these great problems will come to exert a great influence upon the progress of agriculture. It is the work of theorists that is here directing, stimulating and explaining, and it is changing the present haphazard experimentation, with its great loss of time and money, into accurate control.

If farmers would only do a little experimenting on their own account, each laying aside a small piece of ground for making tests, they would learn more of practical advantage than by following, year in and year out, the methods handed down by their forefathers. They would be doing a little scientific explanation, and though this might not immediately give them an additional bale of cotton, in time it would give them much more than that and would fill them with greater interest for their daily labors. The farmers are the backbone of the nation, and that spine must not get the rheumatism. A man must look before he leap, and science does the looking. As Franklin put it: "The eye of a master will do more work than both his hands." Indeed, the farmer comes into close touch with biological problems because his business is directly with plants and animals, and though he does not know it he is really a biologist in the rough. When the competition for market becomes keener, and it continues to do so as men become more trained, only he will be able to succeed who is armed with a working theory and by means of it aims at better results. In farming it is not the land so much as the man. To get at a new plan so as to use his time and brawn to the best advantage, the farmer must begin to explain and must use the explanations of science. A hen can not grow into a rooster, but it can be made to lay two eggs a day. The question of the qualities and possibilities of living beings is the subject-matter of biology, and the more we understand them the more we can use them. But we must remember that we can apply only when

close study has suggested a method, and for that preliminary study to be effective it must not be hampered by the thought of immediate practical returns. Had Darwin in mind the improvement of domestic races of pigeons and poultry instead of the explanation of their origin, he would have contributed much less than he did to be put to practical use. Therefore the farmer should cease to look upon biology as an expense and luxury meant to entertain rich men's sons; he should recognize that any laboratory that is helping to analyze the energies of life is contributing something, indirect but none the less important, to further our usage of plants and animals.

These views are by no means generally held; they have to be taught. To transmit the new ideas of each generation is the business of teachers, and we may now discuss what kind of men make the best kind of teachers. To this I would answer that, other things being equal, the investigator makes the best teacher. For the teacher's duty is not so much to inform as to interest, and the greater interest he has in his own subject the greater influence he will be likely to have over his pupils. Clearly, then, the investigator should teach well because he has the enthusiasm to undertake the difficult task of advancing his subject. Further than this, he can best treat his subject because he has won knowledge for himself as well as through others, he most fully realize the difficulties and problems, and he should be the least likely to pin his faith to unfounded theories. On the other hand, that teacher can not have great influence who has learned simply from his school and college courses and from text-books, and who has not tried to penetrate into the fascinating field that lies beyond. Louis Agassiz was the greatest teacher of natural science that this country has yet enjoyed, and he was through and through an investigator; take the example of any man whose students have been led to follow his profession, and you will find he was an original thinker. One man may be a very storehouse of detailed information, yet be unable to teach, for too much knowledge is an impediment to clear thought. Another may be ignorant of many things, which is really a desirable quality, and because of his creative spirit of research be an inspiring teacher. The teacher's business is not to drill his students so that they soak in facts like so many sponges; but he should give them the wish to blossom and break into fruit of their own. Were encyclopedic knowledge the ideal, one generation would receive the knowledge of the preceding, no more, and the centuries when such conditions prevailed were well termed the dark ages. The teacher should create as well as transmit, for creation strengthens his teaching quality. Thus it happens that in the long run it is pure science that is forwarding every movement in general education. We find a parallel in the case of musicians: there are many with a good technique, but very few with the power to com-

pose; the former are copyists and the latter creators. Now, what could the technicians do without the composers? Appliers are dependent upon fertile creators in general education as in music and other matters. It is pure science by which a man can advance his subject a little and arouse his students to do the same.

It may seem a sweeping statement, but I am inclined to believe that any advance in pure science helps to better our race, whether all of it can be practically applied or not. For so many practical uses have been made from what seemed unpromising theories, that we may confidently expect still more applications in the future. That is one side of the subject. The other and the more important is the growth of the method of science, to never rest content, but to seek to explain more and more. This means a continuous expansion of the field of thought and will prevent crystallization and stagnation. Just because human progress is to such great extent mental, creative thought should be held an important ideal, and this is the essence of science. Thus the mere pursuit of science, whether it be of direct material advantage or not, is by no means worthless to us, for it is a powerful factor in the progress of the human mind. I do not believe in the argument of the schoolmen, that a subject is to be studied for the mental training; life is too short for duties of that kind; what we need is the introduction of more subjects that enlarge our interests, and teach that there is a great deal under the sun that is new and inspiring. My particular argument may seem to many rather specious, yet I think that just in this point is pure science of great value. Men ask for quick, tangible results, for early harvesting of the crops. But that which is easiest and quickest need not be best. What influence each of us most deeply in our personal lives are intangible matters, feelings and desires that are hard to define and that are set apart from the daily occupation. Just so it is with our progress from generation to generation; it is the clarifying and ennobling thought rather than the dollar that gives the most enduring satisfaction whether we are ready to admit it or not. And if you ask proof for this statement, you may find it in any national biography where you discover the names of thinkers, not those of mere money-getters.

Our advance in civilization consists to large extent in the perfecting of the social state, and herein lies the important task of sociology. Numerous have been the proposals for bettering social conditions, and as great the clash of view, for such questions press on all of us. All admit the imperfection and injustice of present conditions, yet there is no general remedy in promise. The most we seem able to do is to mitigate here and there a few of the most urgent evils. It would seem that economists have dealt with only parts of the problem; they have spent much time in definitions, but so far have missed giving a scientific

foundation to the whole subject. For in their examinations of human communities and governments they have limited themselves to man, and to large extent to man within the periods of graven and written history. The chief criticism that biology presses on sociology is that sociology has not yet taken the broad comparative and genetic method. The physician has learned that to understand the human body he must constantly make comparisons with the lower animals; indeed, the progress of medicine, as we have seen, is due to such a method. The psychologist is also recognizing that to explain human mental states he must go back of man; must trace mind from its beginnings, for biologists have shown that even the simplest one-celled animals exhibit memory, attention, volition as expressed by choice, and still other mental states. But so far the sociologist appears to have missed this method and has also failed to go back to the beginnings of the social state. Would you say that it seems ridiculous to expect complex social life among the lower animals? Biology has made known animal communities that in all respects are more fitted to their conditions of life and more harmonious than ever was human society. Nearly all conceivable social states are exhibited by animals. For there are associations of entirely different species of animals, even of animals with plants, the condition known as symbiosis, where each is necessary to the life of the other; this is a life partnership. There are quite opposite kinds of social conditions, parasitism, where the one gets most of the benefit and the other most of the injury; this animal parasite has its resemblance to the human plutocrat. Again, there are associations of individuals of the same species, societies that have developed out of the maternal instinct, the instinct of the mother to care for her young; the social state has arisen in such cases by the mother remaining with her young until the latter are full grown. The beginning of the family we find in the mother fish who guards the young against the father, or the spider who carries her young upon her back; endless are the curious instances of such single families. Out of these have arisen higher social states by the young remaining together after maturing, held together by the control of the mother. In the animals this is generally a matriarchate, or at least a feminine rule, for among the lower animals it is the males that have no suffrage. Thus has grown up that wonderful socialism of the honey bee, admired by men since the beginning of history. Here the queen mother is the single reproductive individual, wherefore she is guarded and fed; but save for her annual outburst, a pettishness allowed to royalty, when she leads a swarm out of the hive, she is virtually a prisoner and the government is carried out by the workers, who regulate the life of their queen more precisely than we are able to do by any written constitution, while at the same time they gather all the food, pasteurize and store it, nurse the young, secrete

the wax and build of it the geometrical comb, even ventilate the hive. No wonder that men sit for hours in their gardens contemplating such organized unity. The drones, they represent a plutocracy, they have but one mission and when that is accomplished the workers kill them. Different wild bees and wasps exhibit various stages leading up to this complex state. Yet still more wonderful governments are known among the ants, with their different castes of workers, each with its particular set of occupations, with their more complex nests with granaries, dining-chambers and bed-rooms; with their habits of harvesting, of keeping milch cattle and providing stables for them, of cleansing the young, of growing and tending mushroom beds, true vegetable gardens beneath the earth, with even the habits of keeping slaves and guests. Ants also have a language by which they communicate their ideas to each other, not by articulate words, but by touch and smell; and certain solitary wasps are known that make use of a stone as a tool, a faculty generally supposed to be limited to mankind.

Now, such cases have been discovered by biologists, and biologists are analyzing their evolution. Pure science has made them known for the pleasure of the work and of the explanation. Yet it is not idle to suppose that such study may yet have its bearings on human social problems. Three practical men have turned with profit to the study of the social life of insects: McCook, the American preacher; Lubbock, the English parliamentarian, and Maeterlinck, the Belgian novelist. Robert Bruce got inspiration from a spider, and engineers have studied with profit the architectural skill of insects and spiders, particularly with regard to bridge making. The study of bees offers much more than the mere output of commercial honey. These lower animals show the real natural state of society, and make ridiculous Rousseau's wild imaginings. They have their trades, their agriculture and animal breeding, their guests and slaves, even their tools; they construct an eminently appropriate architecture with no waste of material, they store food and keep their cities clean and aseptic; some show even the beginnings of barter and exchange. Most of these occupations we generally suppose to be limited to ourselves, for we are nothing if not egotistic. The wonder of it is the perfect order and harmony, the excellence of the state. Willoughby was undoubtedly wrong in arguing that the state exists only in the case of man. Now, can sociology afford to disregard such data? Can the conflicting factors of human society be explained only by the study of man? Surely we ought to at least wrest from the insects their secret of perfect harmony. Many of man's occupations extend far back into nature, therefore to understand them we must trace them to the community life of lower animals, even back of this to the origin of the factor that made the family, the maternal instinct. Sociology has applied some of the teachings of pure science,

such as the operation of selection and the struggle for existence. But if it is to have a scientific foundation it must base itself on the comparative study of community life.

I do not mean that the study of an ant family will give us any better system of taxation. But I do mean that the careful study of lower social states will lay a firmer basis to the general subject of sociology, and thus come to better human conditions. Then also our treatment of criminals must to large extent rest upon biology, for the main practical question involved is whether criminal traits and tendencies are inherited or whether they are learned. The whole subject of heredity is a biological one, and the outsiders who have ventured into this field have given no solutions. How we shall treat criminals and their children will depend upon the outcome of the theoretical investigation of heredity.

Much more might be said concerning the practical value of pure science, but I will mention only one more point, and that right briefly. It is ethical and is perhaps the most important of all. Science seeks the truth, and respects no opinion that does not represent the truth. Science is not so much materialistic as realistic, and it has to do only with what may be determined by experiment and observation. Like the every-day practical man, the scientist holds that those things that seem outside of himself are really outside, and not existent simply in his own mind; and he is striving to explain the relation of those things to each other and to himself. While confining himself to such subjects he does not, in fact, has no right to, imply that there are not other fields of thought. But with regard to the world of things, he claims the right to decide what is real and what is unreal. That man is valued the most in science who sees the truth most clearly, and states it most simply. Right or wrong in science is then a measure of the truth. The great outcome of scientific thought is the unity of all nature, and the great aim in view is the truth. Thoughts like these must come to profoundly modify systems of ethics. Science has a difficult road to travel, for it keeps pushing steadily onward into dark places. In the nature of the case it must make many mistakes, but it keeps the right ideal. The idea of the truth and the ways of reaching it may continue to change as they have in the past, but humanity can not go far wrong so long as it earnestly seeks the truth.

These matters are worth thinking about when there is so much discussion about the value of higher education. We hear protests against the cost of maintaining universities, and there are some people who honestly suppose that the higher seats of learning should be self-supporting. Indeed there was one college started in the east by a millionaire, and he was greatly surprised to find that he was to get no dividends. Education is never satisfied; it uses greedily all available

funds, then calls for more. If an institution does not receive an increasing amount each year, it is not only standing still, but it is also going backward, for it gets more and more behind the times. Practical men are quite right in inquiring whether there is going to be some return to them out of this expenditure, and we have to answer them truthfully. Universities and museums and libraries, the centers of scientific activity, have enormous mouths that are always agape, like overgrown nestling birds. You put money into them, but you do not get money back, at least not directly. This point is very certain and there is no use trying to hide it. But what you do get back are ideas, new ideas. Much of the work represented by such institutions is scientific, and if you endow them you help to increase the ideas that make possible practical ends. You will notice that I have not been arguing for the prosecution of applied science, more properly, the applications of science, for the value of this is apparent to all. I have been speaking for the pursuit of pure science, because it is the necessary forerunner to any new practical application. This is the fact I wish to drive home because it is seldom understood. Scientists themselves often do not realize it, but think that pure science should be studied, even if it can never be made to touch the needs of human life. Men who are not scientists are apt to shrug their shoulders and to say that science may be interesting to some, but that they can not see the use of it and consequently can not see the value of education in pure science. So long as this remains the point of view, higher education and research must have the old hard road to travel. But if we will open our eyes to the fact that even pure science is really of useful value, and its history is proof of this, then the standing objection to higher education will be removed.

THE PHYSIQUE OF SCHOLARS, ATHLETES AND THE AVERAGE STUDENT

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IN the year 1893 Dr. W. T. Porter, now professor of comparative physiology in the Harvard Medical School, examined some 30,000 children who were attending the public schools of St. Louis, Mo. He found that among pupils of the same age, ranging from 6 to 18 years, the average height and weight of those who were in the higher grades were greater than that of those who were in the lower grades. In other words he found that those pupils who were mentally the most precocious were also physically the most precocious. This announcement called forth considerable criticism at the time, and many teachers, recalling a number of exceptionally bright pupils who were small in stature for their age, doubted the truth of the statement. It is of great scientific interest, therefore, to note that Porter's conclusions have since been confirmed by observations made by Hastings in Omaha, Nebr., by Byer in Cambridge, Christopher in Chicago, Roberts in London, Burgerstein in Vienna and by Leharzig in St. Petersburg. In the face of such a body of concurrent statistics from different parts of this country and Europe, no one can doubt for a moment the natural relationship between a vigorous brain and a vigorous body. Moreover this intimate relationship between body and mind does not appear to be limited to growing youth as shown by the statistics to which I have just referred, but it is true of all classes of individuals when taken collectively. For instance the fellows of the Royal Society of England and the English professional class, who may be said to represent the greatest brain power of the British Empire, average respectively 5 feet 9¾ inches and 5 feet 9¼ inches in height and 160 pounds in weight; while lunatics, criminals, idiots and imbeciles who may be said to represent the other end of the intellectual scale, if they are not classed as mentally defective, average in height from 5 feet 7 inches to 5 feet 4.87 inches, and average in weight from 147 pounds to 123 pounds. Here is a difference of 4.88 inches in average height and 37 pounds in average weight between the highest and lowest classes of English society as represented by members of the Royal Society and idiots and imbeciles. Compared with the general population, lunatics according to Roberts show a deficiency of stature of 1.96 inches and

of weight 10.3 pounds; and criminals of 2.06 inches and 17.8 pounds, indicating a deficiency of physical as well as mental stamina in both these unfortunate classes of society.

The physical measurements of the English and American people are so nearly identical, as shown by comparisons which I made with Mr. Galton's measurements some years ago, that conditions that affect one class of persons in England may be said to affect in a similar way the same class of persons in this country. We have already seen that growing youth in different parts of this country and Europe develop mentally as they develop physically, and that the men who have attained the highest degree of intellectual eminence as a class, have invariably had a good physique as shown by their superior height and weight, to back up their superior intellectual vigor. In view of these indisputable facts we should expect to find that the same observations would hold true among college students, who may be said to represent the intermediate class on the way from growing youth to men of intellectual eminence and distinction. According to our physiological law we should expect to find that the students as a class who ranked the highest in scholarship would also have the best physiques, as shown by their superior height and weight. In order to ascertain if this inference be true, I have had the following table compiled from my statistics at Harvard University, from which some very interesting and instructive conclusions may be drawn.

Group	No. of Observ.	Groups on which Observations were Made	Height		Weight		Strength
			C'm.	In.	K'l.	Lbs.	
1	240	University Crew from 1880 to 1900	177.5	69.9	69	152.1	625
2	295	University Football from 1880 to 1900	176.5	69.5	71.5	157.6	652
3	505	Lawrence Scientific School from 1902 to 1906	174.5	68.7	65	143.3	680
4	530	Academic Department from 1904 to 1906	174.5	68.7	63.5	140	650
5	300	First Fifty Strong Men from 1893 to 1900	174	68.5	68.5	151	960
6	77	Honor Scholarship Men, Group I., 1899 to 1906	174	68.5	61	134.5	550
7	300	Honor Scholarship Men, Groups I. & II., '99 to '06	173.5	68.3	61.5	135.6	550
8	232	Honor Scholarship Men, Group II., 1899 to 1906	173	68.1	61.5	135.6	560
9	84	Stipend Scholarship Men, Group III., '99 to '06	172.5	67.9	61.5	135.6	560
10	500000	Average American in 1860 (Army Standard)	172	67.7	61.7	136.05	
11	1000	University Students in 1880	172	67.7	61.3	135.2	490
12	106	Stipend Scholarship Men, Group I., 1899 to 1906	172	67.7	59	130.1	530
13	109	Stipend Scholarship Men in early eighties	171.5	67.5	60	132.3	420
14	431	Stipend Scholarship Men, Groups I., II., III.	171.5	67.5	59.5	131.2	540
15	178	Stipend Scholarship Men, Group II., '99 to '06	170.5	67.1	59	130.1	530

This table consists of the medium measurements of 15 different groups of men, all except Group 10 being composed of students of Harvard University ranging in age from 18 to 26 years. These groups are arranged according to superiority in height and weight. Group No. 1 consists of 240 university crew men, the number whose measurements have been taken since 1880 to 1906. The medium height is seen to be 69.9 inches and the medium weight 152 pounds. Group 2 con-

sists of 295 university football men examined since 1880. The mean height of this group is 69.5 inches, and the mean weight 157.6 pounds. Both the crew and the football groups are composed of picked or selected men, the former being chosen largely for superior height and the latter for superior weight. It will be observed that the strength of both of these groups being 625 and 652, respectively, is lower than some of the groups that follow. The reason for this difference may be explained by stating that prior to 1890 there was no required strength test, and the great majority of the crew and football men in the eighties fell below the present requirement for university athletes, which is 700 points. Group 3 is composed of 505 students who entered the Lawrence Scientific School during the years 1902–6. The height is 68.7 inches, the weight 143.3 pounds, and the strength 680 points. Group 4 is composed of 530 students who entered the academic department during the years 1904–6. The height is 68.7 inches, the same as that of the Scientific School men, but the weight is 140 pounds, or 3.3 pounds less, while the strength is 650, or 30 points less than the Scientific School men. These two groups, comprising some 1,035 undergraduates, are made up of all classes—of athletes, scholarship men, semi-invalids and average students—as they come to the university from the preparatory schools. The Scientific School students are heavier and stronger than the academic students, a fact frequently referred to by the late Professor Shaler, showing his remarkable powers of observation. The most significant facts in regard to these two groups can only be comprehended when they are compared with Group No. 11, comprising 1,000 students taken from the four classes and all departments of the university in 1880. It will be observed that in 1880 the medium height of the university student was only 67.7 inches, although the group contained many men who had been in college three and four years. The medium weight of this group was 135.2 pounds and the total strength 490 points. The average weight and height of the Harvard student at this time was about the same as that given for the American youth, ranging from 21 to 26 years of age, who entered the army in 1860. At the present time the average student is an inch taller, and from 4 to 8 pounds heavier than the average student of 1880, while his strength has increased from 490 to 650 and 680, a gain of 140 and 190 points. In 1880 only 50 per cent. of the Harvard students would have surpassed the height and weight of the army average. To-day over 65 per cent. would pass that standard. This is a most remarkable uplift in growth and development for any considerable body of men in any country or community to have attained in 25 years. My only hesitation in accepting this fact as conclusive is the lingering doubt as to what effect the 30 or 40 per cent. of students who are never weighed or measured at the gymnasium might have upon the medium height and weight. The 1,035 men examined from

the Academic Department and Scientific School, as I have stated, comprised all classes, including the short as well as the tall and the weak as well as the strong, and may, therefore, be regarded as fairly representative of the physique of the college.

It may surprise many to learn that the strongest men in college as a class are below the average student in stature. This is perfectly consistent with established facts. Strength is more a matter of shortness and thickness of arms and legs than of great length of limbs, which is likely to be the physical characteristic of speed, as shown by runners and oarsmen, rather than strength and endurance. The superior musculature of the strong man is indicated by his superior weight. In this respect it is observed that he weighs from 7 to 10 pounds more than the average student, while he surpasses this man in strength by some 300 points.

Having ascertained the medium height and weight of what we have termed the average student, let us turn our attention to the same measurements of scholarship men. It is interesting and instructive to observe that the scholarship men when taken in large groups tend to verify the conclusions reached by Drs. Porter, Byer, Christopher, Roberts, Leharzig and others as to the correlation of a superior mind with a superior body. This is shown rather strikingly by the order in which the scholarship men group themselves according to height, the highest scholars in Group I. being tallest, those in Group II. being nearly one half inch shorter. The scholarships in Group III. are not awarded according to college rank, but for some other special consideration. Although the order among the scholarship men themselves remains the same, that is, the highest scholars as represented by Group I. being the tallest, Group II. over one half inch shorter, etc., the great discrepancy between the height of the honor scholarship men, the stipend scholarship men, and the average student seems at once inconsistent with our premises. Although the honor scholarship men have risen nearly three quarters of an inch in height above the average university student of 1880, the average stipend scholarship men as shown in Group 14 (I., II. and III.) are about one quarter of an inch shorter. There is a difference of 1.2 inch between the height of the average student of to-day and the average stipend scholarship men, and a difference of three quarters of an inch between the average stipend scholarship men and the average honor scholarship men. The discrepancy between the average weight of the different groups is not so regular or well marked as that of the height, although it will be observed that there is a difference of 4.4 pounds between the average student and the honor scholarship men and a difference of 8.8 between the average student and the stipend scholarship men.

The comparison of strength between the average student and the scholarship men is rather more favorable to the latter. Although

there is some 100 points difference in the tests of Groups 3, 4, and 7 and 14, all the groups of scholarship men have surpassed the strength test of the average university student of 1880. The height and weight of the student within normal limits may be said to represent his potential strength and vital capacity. The actual test of strength gauges his real functional power—or would so gauge it if each student tried to do the best he could. While the required physical test for athletes and scholarship men has undoubtedly stimulated many students to make greater physical efforts in preparation for the examination, it has made many of them simply content in doing just about enough to pass the minimum requirement. This in a measure accounts for the more uniform tests of the scholarship men, and the little difference between Groups I., II. and III. The average student, as shown in Groups 3 and 4 is more likely to try to make a good strength test than the scholarship men, as he is desirous of passing the minimal requirement for the athletic teams, in order to be eligible to one or more of these organizations. Although the average height and weight of all the scholarship men are below the average student of to-day, the average of the honor scholarship men is considerably above the average of the university students of 1880—while the average of the stipend scholarship men of the present time is not only below the average students of that year in point of weight, but is below the average of the stipend men of the early eighties. Although the number of men in Groups 6 and 9 is rather small to base definite conclusions upon, the numbers in the other groups are large enough to give conclusive evidence of the trend of physical development in the three great classes of Harvard students, namely, the scholars, athletes and the average students. The discrepancy in the physical measurements of the several groups of scholarship men and the average students raises questions which are in my opinion worthy of grave consideration. The physical superiority of Group I. over Group II. in point of height among both the honor and stipend class of scholarship men is perfectly consistent with acknowledged physiological truths in regard to mental and physical development. But the dominating factors that determine stature and weight are age, race and nurture. The medium or average age of Group I. of stipend scholarship men is 19 years, of Group II. 20 years, of Group III. 19 years and 3 months, and the Lawrence Scientific School Scholarship Group is 22 years. The average age of Groups I. and II. of the honor scholarship men is 18 years and 6 months, respectively. Here it will be noted that the honor scholarship men, though the youngest are the tallest, heaviest and strongest. Does the advanced age of the stipend men indicate inferior natural ability or retardation in mental and physical development due to preoccupation with other work? In either case the question also arises whether the

stipend man's scholarship standing is not due to industry and patient application rather than to superior organic vigor.

In regard to race it is interesting to note that 77 per cent. of Group I. and 75 per cent. of Group II. of honor scholarship men were Americans, while only 62 and 71.5 per cent., respectively, of Groups I. and II. of stipend scholarship men were Americans. The Hebrew race had the next largest per cent., being 15.5 and 11 per cent. in the I. and II. honor scholarship class and 11.3 and 7.75 per cent., respectively, in the stipend scholarship class. But the English and Polish Hebrews, from whom the American Hebrews have largely descended, average only 66.5 inches and 63.8 inches, respectively, in height. The other races, all averaging below the Americans, except the English and Scotch, are represented by a very small per cent. in any of the groups, but the largest number of foreigners, from 30 to 40 per cent., is in the stipend scholarship class. In a measure, this fact would help account for the inferior stature of this class of students. The differences in height and weight, due to nurture in adults of the same age, sex and race, averages as high as 3½ inches in stature and 7 pounds in weight. The honor scholarship men are presumably better nurtured than the stipend scholarship men, coming as they do from wealthier families where they have been better housed, fed and clothed, and better cared for generally. The difference between the average of Group I. of honor men and Group II. of stipend men is 1.4 inches in height and 4.4 pounds in weight. This extreme difference is probably partly due to race inheritance, and partly due to nurture, but what may be termed the organic or physiological factor plays an equally important part. It will be observed that there is little variation in weight between the different groups of scholarship men, in the honor men Group I. actually weighing over a pound less than Group II., and the stipend men of Group I. only equal the weight of Group II.

It will also be noticed that there is a close correlation between the weight and the strength in the different groups. This diminutive weight upon the part of all scholarship men may be accounted for in several ways. The most reasonable explanations, however, are lack of sufficient physical exercise, and mental over-training. In order to meet the demands of the present scholarship standard it is necessary to hold oneself down to many hours of highly concentrated and long-sustained mental effort. Under these circumstances the respiration and circulation are slowed down, the digestion is more or less imperfect, and the organic activity of all parts of the body except the brain is sadly interfered with. The body for the time being is literally being starved in order that the brain may be surfeited. If this intense mental activity is followed by a moderate amount of physical exercise, in which the large masses of muscle in the trunk and limbs are vigorously used, no harm follows from hard study. In developing the mus-

cular system one not only adds to girth of trunk and limbs, and consequently to weight as seen in the physical condition of the 300 strong men in Group 5, but increases the functional power of heart, lungs, stomach and viscera—and consequently favors the nutrition and recuperation of the brain itself. If to intense or prolonged mental application are added worry, anxiety, fear of failure, loss of sleep, or great emotional strain—then mental work soon becomes exhausting. Add to prolonged physical effort the same kind of mental and emotional harrassments, and we soon have in the individual or athletic team a temporary state of physical and mental impairment which is familiarly attributed to "over-training." No one symptom is more indicative of this approaching collapse than loss of weight, and on the other hand no physical sign presages a return to bodily and mental efficiency more unerringly than a return to normal weight. Normal weight for the average student is about 2.05 pounds for every inch in height, for the university crews 2.17 and for the football teams and strong men 2.20. The army standard during the civil war was 2 pounds to the inch for the soldier of medium height.

The Harvard scholarship men range in weight from 1.87 in the lowest group to 1.99 in the highest. These chronic conditions of underweight on the part of the scholarship men are, in my opinion, largely due to excessive mental activity, accompanied in many cases by nervous anxiety and perpetual worry for fear that they will not come up to the desired standard and fail to receive honors or lose their scholarship stipend. Judicious physical exercise, out-of-door games and recreations, mingled freely with innocent social amusements, all tend to relieve this state of nervous tension and malnutrition, as many a hard-worked student knows from experience. The physical superiority of the honor scholarship men over the stipend scholarship men may be largely attributed to the fact that they do devote more time and attention to the care of their physique. When the stipend scholarship men are asked why they do not give more attention to their health and the upbuilding of their bodies, the almost invariable answer is: "We have no time for it," or words to that effect. In many cases this is literally true, as there are scholarship men at Harvard who have to do a considerable amount of outside work in addition to their college work in order to earn money enough to meet their expenses. But in the great majority of cases the answer of "no time" means that these men do not regard health and physical vigor of sufficient importance to work for it; or if they do, they fear that while they are taking time for improving their bodies, their nearest rivals are at the everlasting grind that will give them possession of the much-coveted scholarships. Some of the results are shown in the table to which we have referred. Here is an anomalous condition.

According to our records the physique of athletes and the average

student during the past 25 years has greatly improved, while the physique of all the scholarship men of to-day is not only below the average student of the present time, but the physique of the stipend scholarship men is actually below that of the average student of 1880, and Group II. below the average of the stipend men in the early eighties. As the records we have quoted give for the most part the first-year measurements and tests of the students, they may be said to reflect the conditions that have acted upon them at their homes and preparatory schools rather than at the college. These formative influences, whatever they may have been, have affected the scholarship men as well as the athletes, but in a different way. The great interest that has been awakened during the past quarter century in health, hygiene, sanitation and physical education has begun to make itself felt throughout the country at large, and students are coming to the college now in better physical condition than ever before. This improved physical well-being has undoubtedly been greatly intensified by the time and attention given to athletics in the preparatory schools. The public interest awakened and the extensive advertising that athletes have received through the press have fired a considerable portion of our youth with an ambition to become large, strong and athletic. On the other hand, the intense mental and nervous activity of the age, the universal demand for a higher and broader intelligence, the great rewards for professional knowledge and skill, the prestige and traditions of the institutions of learning, have all combined to stimulate another set of our youth to great mental efforts. If athletics advertise the college, as so many persons affirm, they will tend to draw to its halls the young men who are fond of participating in athletic sports or of witnessing the athletic performances of others. Young men of a more studious frame of mind, who care little about athletics, would be attracted by the reputation of the individual professors, the academic standing of the institution, and the eminence of the positions held by its graduates.

It is very evident that a process of selection has been going on in the community during the past half century by which these two distinct types of young men, whom we may term scholars and athletes, have been attracted to the colleges and universities. Is this process of selection a natural one, or such a one as should exist in an institution of learning? Both classes have ideals and aims which are essentially different. Both classes are naturally antagonistic, and both classes are pursuing the means of education and training as though they were ends in themselves. The consequence is superior physiques with mediocre mental ability according to the college rank-book in one class, and inferior physiques with fine mental attainments in the other. Moreover, this want of harmony or sense of proportion between mental and physical efforts on the part of our students, which we all recognize,

is greatly intensified by that crying evil of the age, the spirit of competition. Competition is to-day the arch enemy of all true culture, mental as well as physical. To recount all of the evils that may be attributed to this factor in education would prolong this article to an unwarrantable length. Let me return, therefore, to my premises.

If there is any truth in statistics the world's work and greatest achievements are to be attained by the men as a class who have the best brains in the best bodies. A large part of the athletic class will fail in the race of life for want of better trained minds, while an equally large class of scholarship men will be eliminated from the struggle for the want of more efficient bodies. What is the college doing to even up the chances of these two classes in their preparation for their life's work? She insists upon a required mental examination of all students, athletes included, upon entering college. Moreover, most colleges now require athletic students to attain a certain grade in their mental pursuits before they can be permitted to contend for honors in athletics. Would it not be altogether desirable for these colleges to require all scholarship men to attain a certain standard in their physical work before allowing them to compete for honors in scholarship? Such a plan would at least put the scholarly man on an equal footing with the athlete and give him a chance to attain something of that mental force, physical vigor and sustained energy upon which his success in life will so largely depend. Furthermore, inasmuch as the greatest amount of physical as well as mental improvement of which the individual is capable must take place during the formative period of his youth—should not the student come to college prepared physically as well as mentally for the ordeal before him? The moral effect of a physical requirement would be to throw the responsibility for physical condition back upon the parent, the preparatory schools and teachers, as well as upon the pupil himself. In my opinion a large part of the community is already prepared to meet this responsibility, as is indicated by the improved physical condition of the average student when he enters college. We have already shown that love of sports, games and physical exercise for themselves do not appeal to the scholarship student. The thing necessary is academic recognition of good health and physical vigor as an asset in education. In taking this step the college would simply be making a practical application of its own teaching. But in so doing it would not only improve the physique of the scholarship man, and thus increase his respect for physical training and athletics, but it would also increase the respect of the mass of students for scholarship men and scholarly attainments.

MODERN AND EARLY WORK UPON THE QUESTION OF ROOT EXCRETIONS

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AFTER the lapse of over half a century the one-time well-known theory of De Candolle has again come into prominence. The demonstration that De Candolle was essentially correct in his deductions revives interest in a phase of plant physiology which has been comparatively unnoticed for many years. In brief, his theory was that plants excrete from their roots substances which are deleterious to continued growth. These excreted substances were believed to have a deleterious effect when absorbed from the soil by other plants belonging to the same order as the plants from which the excretions came, but according to the De Candollian theory the excretions would be harmless or even beneficial to plants belonging to a different order.

Although this theory was supported by numerous botanists and chemists of the last century, it has come to be known in the literature as "De Candolle's theory of root excretions." There is obviously a twofold reason for this: first of all, the prominence of the man himself in his own and subsequent times and, secondly, the fact that he used this theory to explain the well-known benefits of crop rotation in agriculture.

Before the work of De Candolle appeared, Brugmans had alleged that he observed drops of liquid to exude from the roots of *Viola arvensis* and that he had observed small fragments of material at the extremities of the roots of certain other plants which he regarded as excretions. Although his observations were made without the precautions necessary for scientific experiment, they appear to have been quite widely accepted by naturalists of the time, among them such men as von Humboldt and De Candolle. To these pioneer workers the idea that there may be noxious substances present in the soil appeared to be the most direct means of explaining many pertinent problems of plant distribution and of agriculture.

De Candolle carried his idea further and used it to explain the apparent antagonisms of certain plants and expressed his belief that they injured their neighbors by the substances exuded from their roots into the soil. He cited the case of the cockscomb, which, he said, appears to have a bad effect upon neighboring vegetation, and euphorbias, which are harmful to the growth of flax, tares to wheat, and thistles to oats.

One of De Candolle's contemporaries, Macaire-Prinsep, carried out some experiments, which for a time gave promise of firmly establishing the existence of plant (or root) excretions. Macaire-Prinsep took up a number of adolescent plants and after carefully washing their roots, placed them in vessels containing rain water. He reported that after eight days the water in which healthy specimens of *Chondrilla* had grown had acquired a yellow tint and a strong odor. The water had a bitter taste and gave a precipitate when added to solutions of lead acetate. The same investigator also reported that water containing the excretions from the roots of peas was fatal to other plants of the same species, but not to wheat plants.

Using these ideas and experiments as a basis, De Candolle formulated a theory to account for the well-known benefits of crop rotation. He expressed a belief that the harmful effects observed when the soil is continuously cropped with the same species are due to an accumulation of noxious excretions. According to his theory, the substances excreted by the roots of one order of plants were not usually harmful to the roots of plants belonging to other natural orders; in fact, they might be slightly beneficial. In support of this idea he cited the incontrovertible observation of every husbandman that in the majority of cases good yields of all crops are obtained from the soil when plants belonging to different natural orders are grown in succession.

De Candolle pointed out that there exist, in a state of nature, natural successions of forest trees in the course of which a given species of tree is completely replaced by another species. According to his observations the first species seemed to disappear because its excretions so filled the soil as to render it unsuitable for the longer growth of that species. It is interesting to note in passing that he published an article in the *Revue française* showing the harm wrought by the decree of Louis XIV. that forests should be perpetually maintained upon forested lands.

De Candolle also made the trenchant observation that when shade trees die from any cause it is very difficult to replace them with trees of the same species.

Using these observations as a foundation, he built up a theory that plants may injure each other by the matter excreted from their roots, and that the success of crop rotation lies in preventing an undue accumulation of excreted material in the soil. He went further and expressed his belief that the excretory matter of the plants of certain families, like the legumes, is not only feebly toxic to themselves, but possesses actual value as a fertilizer for the cereals.

The ideas and observations of De Candolle were not allowed to pass unchallenged, for within a few years controversial articles began to appear.

Unger, and his pupil, Walser, showed that there had been certain flaws in the work of Macaire-Prinsep and made objections to his results. Walser believed that, if Macaire's statements were correct, it would be possible to demonstrate the presence of organic material in the soil similar in composition to that existing within the plants which had grown upon it. Braconnot, making the same assumption, attempted to demonstrate the existence of opium-like bodies by washing the soil on which plants of the poppy family had been grown for several years. He obtained a solution of inorganic compounds, and, in addition, only traces of organic compounds, and concluded that "If organic excretions really take place in the natural state of the plant, they are, as yet, so obscure and so little known as to justify the assumption that some other explanation must be given for the general system of rotation." Working without the proper idea of the difficulties of such a task and without adequate knowledge of the organic compounds in the soil, it is little wonder that they failed to demonstrate the presence of compounds in the soil which might be regarded as excretory matter from plants. They deserve credit, however, for showing that Brugmans had entirely misinterpreted the death of the root-hairs and the decortication of the growing roots and had assumed that this material was solid excretory matter from the living root.

One of the most scientific attempts to study this question appears to have been made by Alfred Gyde, the results of whose work were published in 1846 in the *Transactions* of the Highland and Agricultural Society of Scotland, and which won for the author a premium of twenty sovereigns. His *modus operandi* was to raise plants in pots of garden soil, sand, moss or charcoal; to remove them at different times; carefully wash their roots free from all adherent material and place the root systems in vessels of distilled water. After a certain length of time had elapsed, the composition of the water in the various vessels was studied.

Mr. Gyde reported that the roots imparted to the water soluble substances, to be regarded as excretory material, and that these excretions seemed to be yielded in greater abundance by plants having coarse roots like beans than by those which had finer roots, like wheat. In some instances the water acquired an odor which was separable on the application of heat and could be distilled over when the water was placed in a retort. Plants like the bean and cabbage imparted an odor to the water similar to that which characterizes their leaves. Plants when in bloom were observed to emit more excretory material than when young or when ripening their seed; but in any case the amount of excretion obtained after evaporating the water was very small. When this small amount of organic matter was reapplied to the soil in which other plants were growing, no harmful effects were

observed. Without appreciating the additional factors which would have to be considered in such an experiment, *e. g.*, absorptive power of the soil, action of microorganisms, oxidation, etc., Mr. Gyde concluded that the excretions of plants are not harmful to their kind, but that the necessity for a rotation of crops arises from the depletion of the soil of the mineral plant food constituents. He thus appears to turn, *mirabile dictu,* from a proposition which was partially proved to one for which he had no proof; neither has conclusive proof been afforded by any subsequent investigator.

Professor Johnson in "How Crops Grow" has justly remarked that Mr. Gyde's results are not to be regarded as conclusive proofs for or against the existence of root excretions.

The curiously regular growth of fungi in continually widening circles, known as "fairy rings," presents many questions of scientific interest and it is not surprising to find that the theory of deleterious excretions was called in to explain this phenomenon. If one assumes that harmful excretions are left in the soil by these plants, it is easy to understand how the new and thrifty growth would continually arise on the outer edge of the ring, and thus give rise to the phenomenon observed.

The subject of "fairy rings" appears to have been studied by Way, who admitted, in a paper published in 1847, "that by far the most scientific and intelligent solution of the question is that which was based upon De Candolle's theory of the excretions of plants." But on account of objections which appeared insuperable to him, he was unable to accept it as a final satisfactory explanation.

In connection with the decadence of the De Candollian theory, special mention must be made of Liebig and of his attitude toward the question. At first he pronounced this theory of crop rotation to be the only one "resting on a firm basis." He regarded the experiment of Macaire-Prinsep as positive proof that the roots, probably of all plants, expel substances which can not be utilized in metabolism.

In addition to his extensive investigations upon the chemistry of the soil, Liebig made numerous studies upon the chemistry of the ash constituents of plants. He found that the essential elements were present in the ash of all plants, in quantities which formed a more or less definite ratio for a given plant. Reasoning from these facts, Liebig developed the idea that each plant requires a certain ratio of mineral constituents in the soil, as well as a certain minimum amount. He held firmly to the idea that plants could no more attain their maximum growth in the absence of a proper ratio of these mineral nutrients than when the total quantity was too small. This theory became known as Liebig' theory of mineral requirements.

Liebig's explanation of the benefits of crop rotation followed as a

corollary to his theory of mineral requirements; since plants take their essential constituents in such established ratios they must in time destroy the necessary ratio of these elements in the soil, but when another plant drawing its ash constituents in a different ratio is substituted, it obtains a sufficient supply of nutrients and the soil is thus relieved of exhaustion.

Under the domination of Liebig's theory of mineral requirements, the theory of De Candolle was practically abandoned. Subsequent to his time the mineral matter of both soil and plant claimed paramount attention, and the biological factors connected with soil problems were almost entirely neglected. Unscientific as it now appears, it must be admitted that for several decades Liebig's dictum had more weight than any amount of experimental evidence. It would even appear that his word has been regarded so infallible in certain quarters that further scientific research has been regarded as unnecessary.

The inadequacy of the theory of mineral requirements alone to explain the productivity of soils has been aptly set forth by Coleman in an essay "On the Causes of Fertility or Barrenness of Soils," presented to the Royal Agricultural Society of England. This essay, although written fifty years ago, expresses the status of the problems of the mineral requirements theory as well now as at the time it was written. He says:

> The causes which operate in producing the fertility or barrenness of soils have hitherto to a great extent been shrouded in mystery, not from any want of study, but owing to the difficulties which meet the inquirer at every step, and the fact that most important results frequently depend upon causes which have eluded the search of the experimenter. The science of chemistry it was hoped would afford the key wherewith to unlock the mysteries of nature, but though its discoveries have conferred much practical benefit on the agriculturist, it has up to a very recent period effected comparatively little toward settling the causes of fertility or sterility. The theories of scientific men led us to expect that fertility depended upon the presence of certain mineral substances which were found invariably present in the ashes of plants, and the analysis of a soil it was believed would confirm the practical experience of the farmer; these hopes have been falsified except in the few cases of almost simple soils, such as pure clays and sands. In all other instances the analysis presented the existence in varying proportions of those substances supposed to induce fertility equally in the barren as the fertile soil. The proportion of the various ingredients was next proposed as a sign of quality, but researches into the amount of inorganic matter abstracted by each crop have demonstrated that soils of a mixed character contain abundant supplies of mineral food for numerous crops.

From the time of Liebig and the establishment of his theory of the mineral requirements of plants, there appears to have been no serious discussion of the subject of root excretion until recent years. The reports of the Woburn Experimental Fruit Farm of the Royal

Agricultural Society of England for the past few years contain a series of significant articles by the Duke of Bedford and Dr. Pickering upon the mutual effect of plants upon each other. These authors observed that the growth of young apple and pear trees was severely retarded when grass was allowed to grow about their roots. The harmful effects were much more pronounced in the case of grass than in the case of weeds. Young trees planted in a pasture, with all the sod replaced around them, died during the first season, but when a small circle of sod was permanently removed, they lived. The first supposition was that the injury was due to the removal of plant nutrients, and experiments were accordingly inaugurated to ascertain whether this was the case, but all the experiments answered the question in the negative. Experiments were also conducted to determine whether the removal of water by the grass was the cause of the injury, but again a negative answer was obtained. The results of other experiments showed that the injury could not be ascribed to the presence of an excessive amount of carbon dioxide, or to the lack of oxygen, since the characteristic injury was only observed when grass was growing around the tree roots. The authors finally concluded that the injurious effect of the grass could be due only to some action on the tree roots akin to that of direct poisoning, leaving the question open as to whether this action is due to excretions from the grass or to the changed bacterial action in the soil induced by the presence of grass.

Jones and Morse, of the Vermont Agricultural Experiment Station, have reported observations which indicate that a somewhat similar antagonism exists between butternut trees and the shrubby cinquefoil. They found that the cinquefoil, which grows abundantly in certain localities, was not found under or around butternut trees on a circle fully twice the diameter of the tree-top. Their observations showed that the "dead line" for the cinquefoil is pushed outward year by year as the butternut tree expands, so that the trees may be surrounded by a circle of dead and dying cinquefoil plants bordering the clean grass plot under the tree. Upon closer examination the roots of dead and dying cinquefoil plants were found always to be in close proximity to those of the butternut trees. That the injury was not due to shade or the removal of water is very improbable, since other species of deciduous trees in the same locality were closely surrounded by cinquefoil plants.

The antagonistic effect of roots is also shown by an instructive experiment recently published by Hunt and Cates in a bulletin of the Cornell Agricultural Experiment Station: Rectangular boxes of soil were planted with corn in one end and with common weeds in the opposite end. Where the roots of the two kinds of plants were allowed to intermingle, the corn made less growth than where a partition in

the middle of the boxes kept the roots of the weeds separate from those of the corn. When the partition was present, each sort of plant was confined to half the soil in the box, but, where lacking, one sort of roots appeared to exercise a noxious influence upon the other.

In studying the general question of soil fertility, the laboratories of the Bureau of Soils in the United States Department of Agriculture have obtained some instructive evidence bearing upon this problem of plant excretions. The data obtained from different lines of experimentation all go to prove the truth of the general assumption that plants do excrete substances which may have a toxic action on the species of plants producing them.

The Bureau of Soils has recently published the outcome of some experiments in which several sets of wheat plants were grown in rapid succession on the same soil. The soil was kept in pots and each set of wheat plants was smaller than the one immediately preceding, as might have been predicted, since it is well known that the continuous culture of a given crop on a soil "exhausts" it more rapidly than the culture of diversified crops. In the experiments cited, the growth of the fourth set of plants was in some cases only 30 per cent. of the growth of the first set.

Such cases of apparent exhaustion have generally been assumed to be due to the removal of plant nutrients from the soil by previous crops. Accordingly, experiments were made in which mineral plant nutrients in the form of pure chemicals were added to the soil at the time of planting the successive crops in amounts equal or greater than those removed by the preceding crop. The addition of these supplies of plant food constituents failed, however, to produce a growth of plants equal to the first crop, although they helped the growth of the plants. This possibility of soil exhaustion is still further rendered improbable by the fact that the wheat plants grew only three weeks and during that time they derived much of their food supply from the reserve nutrients stored in the seed; hence the amounts taken from the soil were very small.

To emphasize the action of root excretions upon the soil, experiments were made in which the first set of wheat plants was allowed to grow for only five days, or until the plumules were just beginning to appear above the surface of the soil in the pots, a length of time obviously insufficient to "exhaust" the soil. All the plants were carefully removed and the soil again planted with wheat, simultaneously with the same number of pots of fresh soil. The plants following the five-day crop made only 80 per cent. of the growth of the plants in fresh soil.

The outcome of these experiments is quite strong proof that the cause of these decreased yields is not the depletion of mineral nutri-

ents, but lies rather in the production of unfavorable soil conditions by the excretion of substances from the roots of preceding crops of plants.

The effect of root excretions is strikingly shown by some experiments in which wheat was grown in pure quartz sand. The sand contained a very insignificant amount of plant nutrients, but the young wheat seedlings were able to draw sufficient nourishment from the seed to maintain growth during the time of the experiment. Pots of fresh quartz sand were planted with wheat simultaneously with an equal number of pots containing quartz sand which had previously grown wheat for twenty-one days. The growth of the wheat in the "exhausted" sand was only about 45 per cent. of that in the fresh sand, in spite of the fact that both sets of plants were supplied with nutrients from the seeds. It would be obviously incorrect to ascribe the "exhaustion" of the sand to a depletion of plant nutrients at the outset. The harmful effects following a previous crop appear to be more probably due to the presence of deleterious substances arising in the sand during the growth of that crop.

Evidence from another experiment showed that the roots leave substances in the soil which may be removed by proper treatment. Three crops of wheat seedlings were grown in pots and showed decreasing yields. When the last crop was removed, an aqueous extract of the soil was prepared and used as a nutrient solution in which a fourth set of wheat plants was grown. A portion of the soil extract was shaken with carbon black, which acts as a strong absorbing agent, and filtered free from carbon black at the end of a half hour. When a soil extract possessing deleterious properties is given this treatment with an absorbing agent, it is almost invariably improved, on account of the removal of the harmful substances. In this "exhausted" soil the same results of the carbon black treatment were noticed as in the case of deleterious soil extracts. The extract of the "exhausted" soil produced as good plants, after treatment with carbon black, as the extract of fresh soil treated in the same way.

The antagonistic action of one plant upon another was shown by the harmful effect of trees upon wheat. Small trees were transplanted into paraffine wire pots and kept growing in a greenhouse where optimum conditions of light and moisture could be obtained. Wheat was also planted in each pot and allowed to grow about three weeks. As soon as the first set of wheat plants had been cut and weighed, a second set was planted and this was repeated at intervals of about three weeks, until nine successive crops had been grown, always growing control crops in pots without trees. The growth of the wheat in the pots containing trees was poorer than the controls during the summer while the trees were actively growing, but when autumn came and the trees

entered their resting period, the growth of wheat in the pots became better. It does not seem possible that the harmful effects of the trees could have been due to the removal of plant food; if so, there would have been no increase in the yield in autumn. It seems, therefore, that the presence of the roots must have had some other effect upon the growth of the wheat, as the size of the pots made it necessary for the two kinds of roots to be in close physical relation. That the retarding effect is due to substances excreted by the tree roots seems probable. It was also noted that tree pots that produced as much wheat growth in November as the controls were the ones in which the trees showed the earliest signs of winter rest. These results seem to be conclusive, therefore, in showing that the injurious effect of the trees was due to the excretion of toxic substances from the roots.

These experiments, which may be regarded as furnishing negative evidence upon the problem, were supplemented by others which furnish more direct and conclusive evidence of a positive sort. By taking advantage of the chemotropic sensitiveness of the roots of seedlings, it is possible to employ them as indicators of the presence of their own harmful excretions. It is well known that roots, like other perceptive organs, will curve and grow towards substances possessing beneficial properties, but will curve away from other bodies possessing deleterious properties. Advantage was taken of this reaction to chemical stimuli for showing the presence of deleterious excretions.

Without going into lengthy details of the experiments in this place, it may be said that the method consisted essentially in growing roots in small glass tubes, from which they might escape at suitable openings if any stimulus caused them to turn aside from their normal downward course of growth. In this case there was a stimulus, and it was the deleterious matter excreted from the roots during growth. It was unmistakably shown that the growing roots of healthy plants do excrete deleterious substances in amounts sufficient to exercise an influence upon plant growth. It was shown that roots of wheat are indifferent to substances excreted by plants of another sort, like maize or cowpeas. The excretions from roots of a more closely related plant, like oats, were not as harmful to wheat as excretions from wheat, but more harmful than excretions from the more distantly related plants.

Recent work in the laboratories of the Bureau of Soils has resulted in obtaining organic compounds from "wheat-sick" and "cowpea-sick" soils. At the late meeting of the American Association for the Advancement of Science, held in Chicago, Schreiner and Sullivan reported the results of this work.

Wheat seedlings were grown continuously upon a soil until it became "wheat-sick," and its productiveness for wheat was quite small. This soil when carefully distilled yielded a small quantity of a crystal-

line organic compound which, when dissolved in pure water, exhibited a toxic action upon wheat plants, but was relatively *harmless to cowpeas.* Crystals were similarly obtained from a "cowpea-sick" soil and were found to be harmful to cowpeas, but relatively harmless to wheat plants. Since the same soil in which neither plant was grown yielded none of these substances, it seems only logical to conclude that these substances were formed as a result of the plant growth in that soil.

Data like those briefly presented above have given strong proof of the existence of excretions from the roots of plants, and show that they may exert a harmful effect upon the growth of succeeding crops of the same kind. Without too liberally interpreting these facts, it may be said that the demonstration of root excretions throws a new light upon the interrelation of soils and plants and promises to afford a solution to some important questions. De Candolle and his contemporaries failed to appreciate the agencies in the soil which effect the destruction of deleterious organic substances, and maintained that, once a crop had been grown, the soil would for a long time be unsuitable to that crop. When the majority of soils are kept in what is ordinarily known as "good tilth" by cultivation and continued rotation of crops, it is improbable that root excretions will accumulate to an extent which would be harmful. Processes of oxidation, brought about by proper cultivation, the oxidizing power of roots, and the action of micro-organisms in the soil are important factors in destroying these deleterious substances. It has also been shown that substances ordinarily employed as fertilizers have a destructive action upon toxic substances, especially when aided by the action of plant roots.

It is more than probable that the consideration of the existence of root excretions will also throw considerable light upon the problem of association and migration of species and individuals in the vegetable kingdom. The reasons for the association of certain species in nature have often been studied, but never satisfactorily explained. The same applies to questions of migration and natural succession. It has been shown that such physical factors as light and water play important parts, but they have not been found sufficient to give a satisfactory explanation for all the phenomena.

It would seem that the methods of soil fertility investigations might be applied with profit to the study of plant ecology. The effect of the root excretions from one species upon another might in certain cases prove to be the controlling factor in association. From the evidence already at hand, it would seem that the biological factors play a definite and considerable rôle in these phenomena.

SILVER

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PREVIOUS to 1870 silver was reckoned as one of the precious metals, and possessed, by virtue of an unwritten agreement between the principal nations of the world, a definite value in terms of gold, *viz.*, $1.29 per fine ounce. The metal was never purchasable at less than this figure, and usually commanded a premium, which, during the last century, ranged from nothing up to as high as ten per cent. It is now purely a commodity, like all the other metals except gold, and while the demand has greatly increased since the date just mentioned, the production has nearly quadrupled, and the price has fallen steadily until during last year it averaged 65 cents.

Curiously enough, since this great change silver has become one of the three metals (nickel and copper being the other two) that circulate as coins at a valuation far above their commodity price. This of course is due to the fact that they are by law legal tenders up to certain amounts, but the circumstance illustrates quite well the vagaries of human law when it comes into conflict with those of nature. The American quarter, the English shilling, the Latin Union franc, the German Mark, the Austrian Kroner, the Russian Rouble, all being coins that circulate freely at valuations ranging from twenty to twenty-five cents of our money, would bring, if melted and sold as bullion, little more than half those figures. On the other hand, the Indian rupee, of approximately the same weight and fineness, not being backed by any such law, circulates at its commodity value only, and its purchasing power in the markets of the world fluctuates with the price of the metal.

Silver sometimes occurs in nature in the metallic condition, and it is due to this fact that it has been known from very ancient times. But it is not found like gold, in grains or nuggets in the gravel of stream beds. Its principal habitat is the vein in rock, and hence it may be inferred that in antiquity the quantity possessed by man was much less than that of gold. To primitive man the latter metal was regarded, in a way, as a fragment, or at least a representative of the sun, while silver bore the same relation to the moon in his mind.

When the interior of China becomes well known, it is likely that the remains of very ancient silver mines will be found there, for the

metal has been produced in that nation, in small quantities, from remote antiquity. There are no evidences that India ever possessed any silver mines of note, but in Burmah there have been found extensive slag dumps rich in lead and zinc, and carrying a notable per cent. of the white metal, whence it may be inferred that it was produced there in some quantity at some time in the past. In the little known and very rugged region between Hindustan, the Persian Gulf and the Caspian Sea, embracing the crude nationalities known as Persia, Armenia, Afghanistan and Baluchistan, there has been a small production ever since early historic times, and the same may be said of Asia Minor. The Grecian peninsula, however, possessed a silver-producing region of great importance and high antiquity, from which, as early as 1000 B.C., the metal came in notable quantity. There are no known ancient silver-producing districts of any note in Africa, but the Italian peninsula and Spain yielded the metal in early historic times, the former moderately and the latter very abundantly. In fact, Spain was really the first great silver-mining country of the world.

More than any other metal silver has been intimately associated with the advance of civilization, or rather of that very important department of human activity that is called commerce, meaning thereby international trade. Authentic history seems to begin with the fact of two comparatively peaceful, industrious and frugal races, occupying the rich valleys of the regions now called India and China; and a lot of turbulent, migratory people in western Asia, eastern Europe and northern Africa, who devoted much of their time and energy to fighting and destroying each others' homes. Between the two was the highest and most difficultly passable mountain chain in the world, known now as the Hindoo Koosh and Himalaya Range, which for centuries, and perhaps millenniums kept them apart effectively enough to allow each to develop its own peculiarities. The first, which we distinguish as the Orientals, appear to have settled down at a very early period to agricultural pursuits, and to such peaceful arts and occupations as were naturally the outgrowth of ruralism. Population grew fast, a crude and quiet, yet strong trading capacity developed, religious advance was marked, but was not of the proselyting kind, was more contemplative and introspective. The arts progressed only to a certain point, and then became stationary. Wealth was attained by industry and accumulation mainly, and did not often arise from exploration or conquest. Such luxury and ease as resulted never passed much beyond the barbaric stage. The sciences did not become exact or even organized, and have retained, up to the present day, an air of mysticism. Literature was of the contemplative kind, and produced only a most cumbersome methods of recording itself.

The second, which we may call the Occidentals, advanced along

wholly different lines. Every department of life was more strenuous, and the results, naturally, were more notable. The increase of population was perhaps as great, but the destruction of life by wars and slavery was enormous. The arts flourished, especially architecture, but their product in the shape of buildings, highways, canals, libraries and museums was continually being looted by conquerors, yet this very ruthless destruction seems to have incited rather than discouraged advance and improvements. The sciences were developed up to the point where discovery began, literature to the stage, where it became imperishable because of the invention of comparatively simple methods of writing, society to a state where education was highly prized, religion to the conception of monotheism.

Between these two diverse and different kinds of humanity a trade slowly sprang into existence. It was first, doubtless, by way of the Arabian Sea, which at some time in the distant past was a "mare clausum," a Mediterranean, as the result of a land connection between east Africa and India, by way of Madagascar, the Seychelles and Andaman Islands; and later by caravan routes through the passes of the mountains. The western nations sought the luxurious and decorative products of the eastern, their fabrics of silk and wool, their manufactures of bronze, their gems and jewelry of ivory and jade. What could be given in exchange? It was early discovered that the money of the east was silver, that it was scarce there and its purchasing power great. Consequently when the strenuous west began to produce the metal in quantity, first from the mountains of Persia and Asia Minor, and later in Greece, Italy and Spain, it became possessed of an article with which the products of the east could be obtained. But the west loved war above all things, and had the warrior's immemorial contempt for trade, and so there gradually grew into existence, at the extreme eastern end of the Mediterranean, a nation of traders, the Phœnicians, who took charge of the commerce between the occident and the orient, who never gained any celebrity except along commercial lines, and who for centuries were actually protected in turn by all the great powers of antiquity because of their trading ability, and their knowledge of where and how to get those products of Asia that Europe wanted. We know that the ships of Tyre and Sidon ransacked the shores of the Mediterranean for silver, and were the owners and operators of mines of that metal in Greece, Italy and Spain. Their product was sent overland by caravan, or over sea by ships sailing from ports first on the Persian Gulf, and later on the Red Sea, to India, and exchanged for the manufactures of the east. One of the most valued of these was tin. Malaysia has been from the most remote antiquity, and is to-day, a prolific producer of this metal, and very early in the history of the human race the ex-

tremely desirable qualities of the alloy it made with copper (bronze) became known. For many centuries primitive Europe poured its silver into Asia and sold it for tin. In due time the demand became greater than the supply, and at the same time the product of the European silver mines began to fall off. The price of tin in terms of silver increased greatly. So also did the value of silver. In this crisis, which threatened the very existence of the trade between the east and the west, two remedies were tried. The Greeks, the dominant nation of the time, under Alexander the Great, started out to conquer India, and to find and capture the Asian tin mines, but, as we know, he never got any farther on the way than the valley of the Indus in eastern Hindustan, where he died. Simultaneously the Phœnicians began to search the western world for the metal, and finally found it in Britain. When Cornish tin began to come into the market, the corner that Asia had for so many centuries had on tin was broken, the Malaysian mines fell rapidly into decadence, and the ancient value of silver in the east was resumed. Europe then had the advantage, but as its silver product was on the decline, its trade with India fell away, and the two far separated parts of the world almost forgot each other. Europe, now well supplied with tin and copper, devoted itself to strenuous war and destruction. A thousand years or so later, when the Roman Empire had passed its prime, new silver mines were found in central Europe, and trade with the east began to revive once more. Venice was then the commercial center of the world, and it flourished as long as the Austrian and German silver mines were in bonanza, and when the cream of these was skimmed it began to decline. From that day till the years when Spanish galleons began to bring in silver from the new world, times in Europe were hard, civilization languished, and humanity suffered. Historians call the period the "Dark Ages." History also records the wonderful change that took place when the Mexican and Peruvian silver mines began to pour their flood of treasure into Europe. There was a marvelous revival of industry and of the arts and sciences, and the greater part of it was directly due to the enormous coinage of Mexican silver dollars, and their wide distribution in trade. This coin for three centuries has had a larger circulation, and has become more extensively known than any other tangible product of the hand of man.

From the date of the discovery of America up to about the beginning of the last century, the source of the world's supply of silver was almost entirely the mines of Mexico and of the west coast of South America. The production in this period is estimated by statisticians at nearly 200,000 tons, and its value (then about $30,000 per ton), at $6,000,000,000. The bulk of this vast total went first to Europe, and more than half of it in the shape of coins of American

mintage. The remainder went into European coinage and plate. In those days it was not generally known that American silver always carried more or less gold, or else the methods of parting the two metals was very imperfect. Whichever was the case it is a fact that all the coins made in that period carried from two to five per cent of the yellow metal, and if any quantity of them could be now bought up at the commodity price of silver it would be a most profitable operation to separate the associated gold. This great store of what was, in those days, a money metal of unlimited legal tender value, enabled the new world to buy what it needed of Europe, and permitted the latter to resume its trade with the far east. Thus the old story was repeated. The pioneer, going westward, sends home the wealth he acquires through tremendous hardships, and upon this those who stay behind live luxuriously, or at least comfortably, as long as the good times last. And Spain, who was practically the parent and owner of those parts of the new world whence the metal came, prospered prodigiously, and became the wealthiest of the nations. But in 1810 its much-robbed and over-patient colonies began their struggle for independence. Spain resisted strenuously, and beggared herself in the effort to retain them. One by one, however, they tore themselves loose from her rule. The contest lasted through more than a decade, and during it the silver-mining industry suffered greatly. In South America it was almost suspended. The supply of the metal in Europe for coinage became scant, and trade with the orient again declined. In the middle of this period, when the destructive career of Napoleon was coming to an end, when all Europe was in financial distress, and vast amounts of plate had gone to the melting pot to be transformed into coin, with silver advancing in value (in terms of gold) until it commanded the equivalent of $1.40 to to $1.45 per fine ounce, with existing coinage of some of the nations in process of debasement by the addition of lead and tin to the alloy, England, in 1816, went on the mono-metallic gold basis, and started the train of conditions that later (in 1873) resulted in the complete demonitization of the white metal. And in this connection it is a most curious fact of history that while England in 1816 abandoned silver as a money metal because of its scarcity and high relative value in terms of gold, the rest of the great commercial nations followed her footsteps nearly fifty years later because of its abundance and falling value.

During the long struggle between Spain and her colonies the mining industry of Mexico was also greatly injured. When the country became independent in 1821 it passed into a condition of anarchy that lasted almost a half century. In this period its mines were operated under the greatest disadvantages, and the amounts of the metal exported was comparatively small. But as soon as political affairs in

the republic became settled by the accession of President Diaz to power, the mining industry immediately began to revive, and to-day its output of the white metal exceeds that of any other nation.

Previous to 1859, when silver was first discovered in the United States (in Nevada), silver mining was not an organized industry in any sense of the word, but an occupation dependent largely for success upon the accidental discovery of bonanzas of very rich ore, and the ability to secure labor upon a basis of practical slavery. The Mexican and South American mines were worked by natives who were clothed, fed and sheltered merely to a sufficient extent to keep them alive during the prime of their physical powers. Only one step on the road of progress had been taken in the metallurgy of the metal, namely, the invention of what is known as the "patio process," which depended for its success largely on the element of unlimited time for its operation, coupled with nearly costless animal power. But when it became evident that the Comstock Lode in Nevada contained vast quantities of silver, the natural ingenuity and aptitude of the American transformed mining into a commercial industry, and the metal began to pour in such torrents into the money centers of the world that financiers became alarmed, and between 1870 and 1873 full coinage rights were finally denied by the principal nations. Meantime, a remarkable industry had come into existence in the mountain regions of our west. Thousands of silver mines had been discovered, scores of processes invented and put into practise for the treatment of their ores, and a vast number of metalliferous deposits developed that have since been yielding copper, lead, zinc, iron and manganese in addition to the white metal.

Silver occurs in veins or deposits in the rocky crust of the earth, and is never found in the gravel of stream beds as is gold. In a small number of cases the gangue, or material with which the metal is associated, is quartz alone, but generally one or more of the base metals is present, predominating vastly in quantity, and often in value. This is especially true after a little depth is gained on the veins, so that in due time mines that were opened as straight silver deposits became rather deposits of the other metals, the silver being practically a by-product. A good example of this change is to be found in the lodes of Butte, Montana. The veins at Parral, Pachuca and Guanajuato in Mexico are samples of straight silver mines, yet all of them are showing more or less associated iron or copper as depth is gained. On the other hand, wherever lead is found, silver is always present in some quantity, and, at the Comstock as well as at the Mexican districts just mentioned, there is invariably a proportion of gold. In the Comstock bullion it amounted to 40 per cent. of the total values. Thus the metallurgy of silver ores is not a simple matter, and in the days between 1860 and

1873, when the metal had a value of about $1.30 per ounce, a vast amount of study and experiment was devoted to the question of recovering it from its ores by milling processes, or methods not involving the fusion of the minerals. Preliminary roasting (sometimes in the presence of salt), followed by long-continued grinding with mercury, under water, was the system adopted in the majority of cases, the result being an amalgam of mercury and silver. This was then heated in retorts to volatilize the mercury, and the silver left behind was melted and cast into bars for shipment to market. Other processes involved the use of chemicals by the aid of which the metal was brought into a state of solution, and from which it was recovered by some method of precipitation. But as the west became opened by railroads so that ores could be cheaply transported to natural centers where coal or water power existed and labor was abundant and inexpensive, most of these processes were abandoned in favor of smelting, in which the ores, properly mixed to secure fusion, are melted in a blast furnace. The products are either copper or lead bars—according to the system used—and during the melt the precious metals unite with the baser ones, from which they are subsequently separated by electrolysis. In consequence of all this the production of silver may now be considered as a settled industry, and because the metal is now produced very largely as a by-product.

Since its discovery in the United States, and the application of business methods to the mining of its ores and their treatment, the world's output has amounted to nearly 170,000 tons. There has been nothing comparable to this enormous yield in any previous era of its history, and its fall in value may be considered as warranted, and perhaps permanent. The annual output of the world at the present time averages about 6,000 tons, and is not at all likely to seriously decline. The American and Mexican mines show no signs of exhaustion. On the contrary, new ones are continually being found. Asia and Europe are not likely to become large producers of the metal. The settled parts of the old world have been fairly well explored, and in the unsettled parts like Siberia, Turkey and Africa the mining laws are so burdensome that the prospector and individual miner (who are the advance guard in the exploration of the mineral resources of a land) will have nothing to do with those regions. In Australia somewhat similar conditions prevail. We may, however, confidently look to South America for many new and great silver mines, when the political situation becomes as stable as in Mexico, for Spanish mining law has always recognized the necessity of the prospector at the base of the industry. The extent to which the American crop of silver is a by-product is shown by the following table worked out by the author for

the year 1899, when the product of our mines amounted to about 2,100 tons.

	Tons	Per Cent.
Produced in connection with lead ores	750.75	35.75
Produced in connection with copper ores	514.50	24.50
Produced in connection with gold	504.00	24.00
Produced in connection with iron and manganese	173.25	8.25
Produced from straight ores	157.50	7.50

In Mexico, on account of the activity in Parral, Pachuca and Guanajuato, the proportion of silver coming from straight ores is larger, and perhaps the same is true for South America. But in Europe, Asia and Africa practically the entire product of silver comes from the distinctively lead and copper mines, so that for the entire world the proportions quoted in the above table would be about correct.

The demand for the metal is growing and may be expected to increase markedly in the near future. The largest consumers now, as in the past, are the three great backward races of the far east, the Hindus the Malays and the Chinese. It takes from 2,500 to 3,000 tons every year at present to maintain trade with them, and but one, the people of Hindustan and Farther India, may be said to have been more than wakened from their sleep of centuries. These number about three hundred millions of frugal, industrious and acquisative people. When the four hundred million of Chinamen are thoroughly aroused, and the one hundred million of mixed races that include the Filipinos and the inhabitants of the East Indian Islands, there will come at least as large a call for the metal as that which now exists. For silver is the only money that the orient recognizes, or can use. The capacity of that part of the world for absorbing it has always been the wonder of economists, to whom Asia is known as "the sink of silver." Statistics show that an average of not less than 600 tons of the metal has been sent to the east by Europe annually during the last 300 years. Practically none of it has ever come back. Among the thousand million Asiatics it has disappeared as hoards of coin, or bars, or as ornaments, or is afloat as money. This curious process is in progress to-day with nearly fivefold the vigor of the past. Practically seventy per cent. of all the silver produced in Europe and America since the dawn of history is now in the possession of the Chinese, Japanese, Malays and Hindus. Yet we regard them as a poverty-stricken people, which in fact they are, for with all this immense hoard of what was once the paramount money metal of the world, famine or pestilence is abroad nearly every year in one or more parts of the orient. This vast metallic accumulation will not save them when crops fail and starvation is at hand, for the west, having demonetized silver will not accept it in exchange for food except on the basis of a pure commodity.

From 400 to 500 tons of the metal is at present being consumed by the world in manufactures and the arts. Such parts as are used in photography and by the chemist may be regarded as lost, and it amounts to as much as 50 tons per year. The balance becomes table ware, jewelry and ornaments. About 5,000 tons goes into coinage. Fifty per cent. of this is minted in Asia, approximately twenty-five per cent. in Europe, fifteen per cent. in Mexico and South America and the balance in the United States. All this, except the coinage of India, Mexico and Japan, is bought by the various governments at the commodity value of the metal, and after taking the stamp of the mint goes out to the public on the basis of the old ratio of 16 to 1 as compared with gold. The difference is absorbed as profit, under the name of seignorage. This profit to the treasuries of the civilized nations is now amounting to something more than $10,000,000 per annum, and is somewhat of the nature of a fraud on the people, though with the existing conventions in the matter of money and coinage it is not easy to say how the fraud can be avoided.

Considered wholly by itself, and from the standpoint of its purely physical properties, silver is yet a precious metal. Its pure white color and soft luster can not be approached in aluminum, tin, nickel or any other metal, and though it tarnishes quickly, and has not the resistant qualities of gold to the action of acids and of sulphur, yet no metal we at present know of can take its place for small coinage, or for ordinary table ware and decorative purposes. Aside from these uses it is the best conductor of electricity of all known substances, and there may be a special future for it in the wonderful development of that new servant of man. Perhaps as the science of wireless telegraphy and telephony advances silver may come to be employed in the reproduction of sound waves when great distances must be bridged, or extreme delicacy of enunciation is desired. Yet copper approaches it so closely in electric sensitiveness, and is so much more abundant, and consequently cheaper, that we are not likely to do much of our talking in the future over silver wires.

The world's crop of silver during the year 1907 amounted to about 6,400 tons, and came from the following parts of the globe in about the quantities given:

	Tons		Tons
Mexico	2,300	Europe	760
United States	1,900	Australasia	440
South America	420	Japan	120
Canada	400	China and Malaysia	15
Central America	35	Africa	10
			6,400

From these figures it appears that nearly 80 per cent. of the annual product is coming from the western hemisphere, and if we add to this the output of Australasia, the proportion coming from what may be regarded as the newer parts of the world, so far as the question of its civilization is concerned, rises to 85 per cent. Finally, by including the European product, it will appear that Asia, where the metal is most in demand, and where it still retains all of its old debt-paying quality, produces less than 3 per cent. of the total world's crop. Hence there is still a large field for silver in the orient, and its exploitation and development is undoubtedly the next great task of the Caucasian. And in this view the silver miner may take some comfort.

JAPANESE WRITING

By E. W. SCRIPTURE, Ph.D., M.D.
NEW YORK CITY

SOME time ago a Japanese student handed me the following statement:

In Japan we aim at two distinct objects in giving instruction in writing. One is to teach the children the mode of writing ordinary characters, and to make them acquainted with the management of the brush. But we have another important object in teaching writing; in Japan it is regarded as one of the fine arts. Japan is a land of hero-worship. Nothing delights us more than the memory of great heroes and sages of the past. Every relic connected with them is cherished as a visible token of their great minds. We believe ourselves to be especially inspired and ennobled by their autographs. So the educated classes decorate what is set apart as the sacred part of the room—called "Tokonoma"—with such an autograph. We study the writings of eminent persons as a physiognomist would study the various expressions of human faces to know their inner characteristics. When we are trying to copy after an eminent writer we feel very much as we would when standing in front of a marble statue of a great man. Therefore we pay special attention to the posture of every limb of our body, and especially to the management of the brush, for we think we are in the presence of that hero himself. In that moment we concentrate our mind to direct all the energies of our body in a certain definite direction, in consequence of which our lower passions and appetites are extinguished as the dark clouds of night are dispersed by the radiance of the rising sun, and our spirits are freed from all the cares and anxieties of the present world and are wafted to the ideal region of highest felicity, where we commune with the holy spirits of the great heroes and sages. It was thought by the sages of old that by means of such a method of writing they could regulate the outward postures of their disciples and in consequence could discipline their inner spirits, So they counted the art of writing as one of the "Six Arts" by which they sought to edify man's character.

In Japan writing plays an important part in the social life of the people. On the second of January, on which day the work of the year begins, educated persons—especially the younger people—try their new brushes on specially prepared paper by writing sentiments in praise of nature and by expressing their wishes and hopes for the coming year. The Japanese give writing-parties just as we do lawn-parties and euchre-parties. At these gatherings the guests exhibit their best pieces of writing and receive prizes. Again, a piece of silk with an elegantly written sentiment serves as a highly acceptable wedding present. Even the walls of the rooms are decorated by writings in place of paintings.

FIG. 1. MANNER OF LARGE WRITING.

Writing is also a part of the divine service of Buddha. The empresses and emperors in the olden days made copies of the Sacred Books; the characters were golden on a white field, the style of the letters was dignified and beautiful. There is even a special god of writing, Ten Jin. He was a great statesman, poet and scholar of the olden time, and also a fine writer; he was afterwards deified. Now the children offer up to Ten Jin their early attempts at writing and pray to him for help in the difficult task which has been set before them. The sacredness of the art of writing attaches even to pieces of paper with written characters on them; the Japanese do not allow them to be trampled into oblivion, but carefully pick them up and religiously burn them.

What is our American view of writing? We consider illegible and careless writing a thing to boast of. You have all read Mark Twain's story of the letter from Horace Greeley, and I need not repeat it to

FIG. 2. MANNER OF FINE WRITING.

illustrate the point. The story is told of Rufus Choate that he wrote three hands; one which he could read and his clerk could not, one which his clerk could read and he could not, and one which nobody could read. Of a certain well-known Baltimore clergyman it is stated that he could not read his own manuscript twenty-four hours after he had written it. Similar anecdotes might be collected by the hundred. It does not matter whether they are literally true or not; the fact remains that the humorous way in which bad writing is treated shows that the general public sentiment regards poor writing as a thing to be proud of rather than otherwise.

Writing is to us a means of communication to be used as economically as possible—the biggest amount of communication with the least expenditure of pen-energy. Of course, from this point of view the best writer is the typewriter, and when typewriters are cheap enough we can expect the school-children to be taught typewriting instead of pen-writing.

This commercial view has brought it about that writing is no longer on a level with spelling; bad writing is excusable, but bad spelling never. This careless and frivolous treatment of the art of writing is, I maintain, an ill-bred trait of national character which we should endeavor to correct on the principles followed by the Japanese.

In Japan writing was regarded as one of the six arts of education. By the six arts were meant the postures, writing, riding, shooting, mathematics and music. The object of these arts was to teach the control of both the body and the mind. By writing, the control of the arm, hand and fingers was to be taught. The Japanese use the "Fude," a peculiar kind of brush made of the soft wool of the white rabbit. Fig. 1 shows the position for large writing. The long roll of paper is held in the left hand; the characters are written downward. The stone block on which the stick ink is rubbed in water is shown on the table. In the first stage of writing they have to learn to write large letters and characters. When they want to write large characters, it is forbidden to support the arm on the table or anything else. The movement of the arm must be entirely free in both the horizontal and the vertical direction. Not only are quickness and steadiness of movement required, but the arm is trained also to graceful movement and slow adjustments. Now a bold stroke is demanded and then a hesitating touch of the brush is required. It is said that "Sometimes the stroke of the brush must be as rapid and as dreadful as the lightning in the sky, but sometimes it must be as gentle and as graceful as the young virgin in her private apartment."

In the second stage of writing they have to learn to make smaller characters. Here again the arm must be free; but in this case one point of the wrist is supported on the table, or more properly on the row of fingers of the left hand laid on the table (Fig. 2). This point serves as a fulcrum for the movement of the hand and fingers. The object of finer writing is not only to train the fingers, but also to train the eye. So they are sometimes required to write characters not larger than a millimeter square. Even in writing such a small character, every jot and every tittle must be brushed according to a definite form of writing and by a single stroke.

We must change our American views of writing. In communicating by speech a well-bred person tries to avoid mutilations and transformations of language that might be offensive to cultured ears. The New Englander tries to save his g's, the Southerner to keep his r's, the Englishman not to drop his h's. In communication by writing, however, you may insult your correspondent by characters over which he has to puzzle long to derive any meaning; you may flaunt slovenly y's and g's and b's before his face; you may offend his nostrils with the garlic of reversible n's and u's, etc. This is quite wrong. Let

your "Dear Sir" and your "Yours truly" speak their meanings in their forms as well as in their spelling; treat your friend with the politeness of legibility and feed your correspondence-guest with a meal of words more than half done.

FIG. 3. SPECIMENS OF WRITING.

It is especially when we consider writing as the expression of ourselves that we understand the Japanese feeling toward it. The voice and the hand are two great means of expressing what is in us. Our

thoughts, our instincts, our very natures find expression in the tones of the voice; we are familiar with the effeminate voice, the manly voice, the sympathetic voice, the mean voice. Our hands also tell similar stories, but we have never learned to recognize them because we have not thought the matter worth considering. No facts whatever are yet settled concerning the relation between character and writing, yet that need not trouble us. It is a well-established law that our mind seeks expression by movements and that the practise of the movements tends to confirm the condition of mind that produces them. Certain attitudes are connected by repetition with devotional impulses; the mere assumption of such an attitude will arouse the same impulses. The careful putting of our best instincts into our writing on every occasion can not but have some of the moral effect attributed to such a practise by the Japanese, and the constant effort at clearness, correctness and gracefulness in expression must inevitably have some influence on our inner selves.

THE PROGRESS OF SCIENCE

THE LIFE AND LETTERS OF HERBERT SPENCER

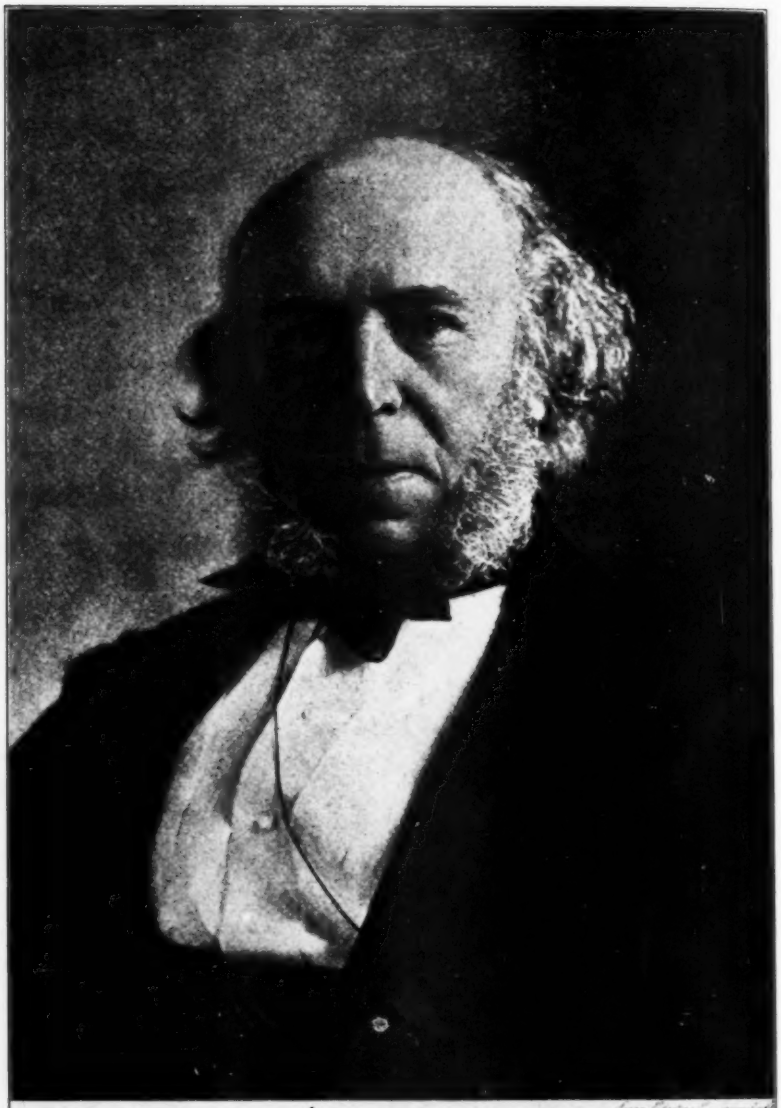
SPENCER'S "Autobiography," stereotyped during his lifetime and published in two large volumes shortly after his death in December, 1903, is now followed by two further volumes, a "Life and Letters," prepared by Dr. David Duncan in accordance with a clause in Spencer's will which read as follows: "I request that the said David Duncan will write a Biography in one volume of moderate size, in which shall be incorporated such biographical materials as I have thought it best not to use myself, together with such selected correspondence and such unpublished papers as may seem of value, and shall include the frontispiece portrait and the profile portraits, and shall add to it a brief account of the part of my life which has passed since the date at which the Autobiography concludes."

Dr. Duncan, who was Spencer's secretary and assistant for two years in the late sixties and was subsequently in India as professor of logic at Madras, had a task made extremely difficult by the preexisting autobiography. This, like all Spencer's works, makes a different appeal to different minds; some find it tedious, while to others it is of absorbing interest. In any case it is a work of genius written by a man of genius. It is so full and complete that most of the material of real interest had been used, except for the last years when Spencer was a confirmed invalid and found his own life wearisome.

Spencer says: "It is a provoking necessity that an autobiography should be egotistic." As a matter of fact the autobiography emphasizes the egotistic, the priggish and the petty sides of his character much less than does the biography, while the true largeness, sincerity and kindliness of the man emerge

HERBERT SPENCER WHEN NINETEEN

HERBERT SPENCER WHEN FORTY-SIX



Herbert Spencer
When 73

in the autobiography more clearly than in Dr. Duncan's pages. Indeed the lack of skill and tact in the biography gives the impression of a tinge of maliciousness. It is all very well to reproduce the accounts of Spencer's amiable foibles, given by Mr. Galton and Lady Courtney, but it is scarcely necessary to quote the letter according to which Carlyle called him "an immeasurable ass," and the amount of space given to his attitude towards the honors he declined, to his misunderstandings with Huxley and Harrison and to the difficulties about his portrait is out of proportion to their significance. It is proper to quote Spencer as writing: "Twice or thrice I have taken up Plato's *Dialogues* and have quickly put them down with more or less irritation," but then it seems scarcely desirable to close the biography with "What -Professor Theodor Gomperz says of Plato may be said of Spencer," etc. The care that Spencer took about his autobiography and biography compared with Darwin's belief that his autobiographical sketch would be of interest only to his children places in sharp relief a real difference in character which is fully confirmed by all we know of the two men. Still, the inference may fairly be drawn that it is better for the reputation of a great man to have his biography written by his son than by his private secretary.

It would not be possible in a brief note to select material from the "Autobiography" and from the "Life and Letters" which would give any impression of Spencer's life and character, and it is of course out of the question to attempt to expound, appreciate or criticize the vast contributions to philosophy and science which have had such a large share in making the evolutionary standpoint dominant everywhere. Readers of this journal are familiar with Spencer's work, for he contributed to it nearly a hundred articles. It was indeed established by Dr. E. L. Youmans in 1872 largely with a view to provide a suitable medium for printing Spencer's "Study of Sociology," and the POPULAR SCIENCE MONTHLY may be regarded as one of the by-products of his genius.

The "Life and Letters" is published by Messrs. D. Appleton and Company, who for fifty years have been performing an important service by giving to American readers authorized editions of the works of Spencer, Darwin and Huxley. By their courtesy we reproduce the accompanying portraits.

THE FINANCIAL STATUS OF THE PROFESSOR IN AMERICA AND IN GERMANY

THE second bulletin of the Carnegie Foundation for the Advancement of Teaching, issued under the title given above, contains information that is of interest not only to those who receive salaries from American colleges and universities, but also to all those who realize that the future of our civilization depends largely on ideals of service and research for which the university is the natural home. There is no more important question than how the best men can be drawn to the universities and how they can be led to do their best work. The part played by salaries in accomplishing these objects is not obvious. It might be that large salaries would attract the wrong kind of men and lead them to spend their time in unwise ways. Ecclesiastical and military organizations, which in the past have developed the ideals of loyalty and service which should now be found at our universities, have not been dependent on salaries, though office and honors have played a considerable part. In an industrial democracy, however, it seems that men are likely to be esteemed in accordance with their incomes, and if the office of professor is to be made honorable it must be well paid, or at least certain positions must exist that are highly paid.

The statistics in regard to salaries

now published by the Carnegie Foundation give details for 103 institutions paying $45,000 a year or more in salaries to the instructing staff, and of 54 smaller institutions which were selected as showing that good results can be obtained with comparatively small resources. The average salary of the full professor in the hundred leading institutions is about $2,500, varying from about $4,800 to about $1,400. Higher salaries are paid in a few cases, but salaries of $5,500 at Harvard or $5,000 at Columbia are practically the maximum money prizes open to teachers. These prizes are not open to free competition; for in this country a professor can as a rule only reach the highest position in his own institution. In this regard, the German method of calling a man freely to what is regarded as a better position has certain advantages. A professor may be called to Berlin at the age of sixty, receiving a higher salary and a more honorable position than any that we have, and this possibility may be a stimulus to good work. Here a man who receives the average salary of $2,500, at the average age of appointment of 35 years, is not usually able to look forward to further promotion. His expenses increase, especially if he has a family, and he finds himself less well off than the successful physician and lawyer in the same town, who are continuously increasing their incomes and the material advantages they can give to their children.

The Harvard plan seems on the whole to be the best hitherto put in practise in this country. After a graded series of promotions and increments of salary, a full professorship is reached at the average age of forty with a salary of $4,000, and the salary is increased by $500, at intervals of five years, until it reaches $5,500. If a man shows unusual ability—ordinarily it must be acknowledged by being called elsewhere—he may be promoted more rapidly than in accordance with the usual routine; in general, however, the salaries are not in proportion to ability or to needs, but are equal with slowly increasing increment. This method and the system of pensions gives security and dignity to the office. It is an open question whether the lessening of competition and ambition which it favors is a good or an evil.

The comparison of the salaries given by different institutions should result in the improvement of conditions where these are unsatisfactory. Thus Syracuse University pays its assistant professors an average salary of $978 and its full professors an average salary of $1,808, and in its non-professorial departments has one instructor for twenty students. Haverford College pays its assistant professors $2,240 and its full professors $3,440 and has one instructor for six or seven students. These are extreme cases, but there are many anomalies in the tables. It is of course true that the effective salary is dependent on the cost and standard of living. A salary of $2,000 in a small town may have as much purchasing power as twice that amount in New York City.

SCIENTIFIC ITEMS

We record with regret the deaths of James Duncan Hague, the American geologist and engineer; of Anceto Garcio Menocal, an eminent Cuban engineer in the service of the United States government; of Mr. Arthur Lister, F.R.S., known for his work on the mycetozoa; of Mylius Erichson, the Danish explorer; of Dr. F. Noll, professor of botany at Halle, and of Dr. Oskar Liebreich, professor of pharmacology at Berlin.

Professor George E. Hale, director of the Solar Observatory of the Carnegie Institution, has been elected a foreign correspondent of the Paris Academy of Sciences in the place of the late Asaph Hall.—Count Zeppelin, on the occasion of his seventieth birthday, has been awarded an honorary doctor-

Joh. Muller.

See the article by Dr. Philip B. Hadley in the June issue.

ate of science by the University of Tübingen. He has also been made an honorary citizen of the cities of Constance and Stuttgart, and has been given the gold medal for art and science by the King of Wittemberg.—M. Bouchard has been elected president of the Paris Academy of Sciences to fill the vacancy caused by the resignation of M. Becquerel to become permanent secretary. M. Picard succeeds M. Bouchard in the vice-presidency.

THE monument in honor of Robert Bunsen, designed by Professor Volz, of Karlsruhe, was unveiled at Heidelberg on August 1.—The German emperor has supported the medical and scientific men in Berlin in objecting to the form of the monument designed in honor of Virchow. It is not a statue of Virchow, but introduces as the chief group a symbolic representation of his lifework, in the form of a struggle between a giant and a fabulous beast, while on a pedestal a medallion portrait of Virchow is placed.

THE San Jacinto Valley in California will hereafter be known as the Cleveland National Forest. It has been so renamed by President Roosevelt in honor of the president under whose administration the first national forests were created. In 1897, in honor of Washington's one hundred and sixty-nfth birthday anniversary, and upon the recommendations of the National Academy of Sciences, President Cleveland created thirteen national forests, containing about 23,000,000 acres. The San Jacinto forest was one of the original thirteen so created.

IN connection with an article by Dr. Philip B. Hadley on Johannes Müller, printed in the June issue of the MONTHLY, there was reproduced a portrait, which it appears was of Johannes von Müller, the Swiss historian. Our attention was called to this error by Professor George H. Parker, of Harvard University, by whose courtesy we are able to give a portrait of the great German physiologist.